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[PLATES 60–63.]

ESEARCHES ON THE STRUCTURE, ORGANIZATION, AND CLASSIFICATION OF THE FOSSIL REPTILIA.

III.—FURTHER EVIDENCES OF THE SKELETON IN DEUTEROSAURUS AND RHOPALODON, FROM THE PERMIAN ROCKS OF RUSSIA.

BY

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XV. *Researches on the Structure, Organization, and Classification of the Fossil Reptilia.*—VIII. *Further Evidences of the Skeleton in* Deuterosaurus *and* Rhopalodon, *from the Permian Rocks of Russia.*

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[Plates 60–63.]

Introduction.

The reptilian remains found in Russia, in Permian rocks west of the Urals, are mostly preserved at the Institute of Mines at St. Petersburg, at the University of Kazan, and the Senckenberg Museum, Frankfort-on-the-Main. They have been collected as isolated bones in working the mines; and the same specimens, in some instances, have been referred to Mammals, Labyrinthodonts, Thecodontosaurians, and Theriodonts. The principal genera described are known as *Brithopus*, *Orthopus*, and *Syodon* of Kutorga, *Zygosaurus*, and *Eurosaurus* of Fischer and Eichwald, *Platyops* of Trautschold, *Rhopalodon* and *Dinosaurus* of Fischer, *Deuterosaurus* of Eichwald, and *Cliorhizodon* of Twelvetrees. After examining the available specimens which are the types of those genera, I concur in regarding *Zygosaurus* and *Platyops* as typical Labyrinthodonts; and that there is no character in the skull of *Melosaurus*, which was regarded by Eichwald as the head of *Eurosaurus*, to make me doubt that it is correctly referred to the Labyrinthodontia. The approximation of the Pareiasaurian skull in external character to this Labyrinthodont type led me to hesitate* before rejecting the genus *Eurosaurus* as defined by Eichwald, but, after studying the type specimens, I believe that the skull, which is preserved at Berlin, is a true Labyrinthodont, and has no connection with the bones among which Eichwald placed it. The separation of the Labyrinthodont from other remains is not yet easy. Labyrinthodont limb-bones unfortunately are known very imperfectly. Even the fine skeleton of *Actinodon*, figured by Professor Gaudry, does not fully display the characters of the humerus. The distinctive characters of the limb-bones of Labyrinthodonts have not been demonstrated, so that it is not possible to compare the Anomodont limb-bones found in Russian Permian rocks with those of the larger

* 'Phil. Trans.,' B, 46, 1889, p. 278.

Russian Labyrinthodonts, which are known from skulls. Those Russian limb-bones appear to me to belong mainly, if not entirely, to one animal type; but there is no conclusive evidence from natural association of the specimens that they should be referred to one or more of the genera which have been described, or to determine whether there is any difference of importance in the skeleton which is associated with the Labyrinthodont skulls, and that associated with the Russian skulls which have a Theriodont type of dentition. On these subjects there is inductive evidence which inclines towards the conclusion that the skeleton of the Russian Permian Labyrinthodonts is unknown. M. Trautschold has ascribed many small fragments of limb-bones to the Labyrinthodont genus *Platyops*, but no one of them is complete. Professor Alexander Stukenberg, of Kasan, has given me the opportunity of studying them fully; and I fail to recognize more than a generic difference between the small specimen ('Moscou Nouv. Mémoires,' vol. 15, t. 5, figs. 1–3), regarded by Trautschold as the left femur of *Platyops Stukenbergi*, and the large specimen which he regards as the right femur of *Brithopus priscus* (*loc. cit.*, t. 6). This type of femur nearly resembles the specimen figured by Eichwald, with the head of the femoral bone still attached to the pelvis ('Lethæa Rossica,' pl. 57, fig. 30). That pelvis is immature, since the constituent bones are separate, but it is unlike any specimen which has been ascribed to a Labyrinthodont. And although it differs from all other specimens from the Russian Permian rocks, in the separation of the pubis and ischium from each other distally, it resembles them in the part of the ilium which is preserved. Hence, though these examples of femora and pelvis differ from others in Russian specimens preserved, the differences between them seem to me more likely to be generic than ordinal, and there are no data for affirming they are Labyrinthodont bones. It is possible there may be only a generic difference between the limb-bones referred to those orders. Leaving the question of the distinctive characters of the appendicular skeleton of the larger Labyrinthodonts, as one upon which there is at present insufficient evidence to establish the nature of its relations to the Pareia saurian or Theriodont skeletons, and discarding skulls with Labyrinthodont dentition, there remain a series of bones in which the skulls have a Theriodont type of dentition, and the vertebræ and limb-bones have much in common with South African types which have been described as Anomodont, Theriodont and Pareiasaurian. There appear to me to be sufficient grounds in these resemblances in detail for associating the isolated bones as portions of the skeletons of one group of animals.

The remains with a Theriodont dentition show two generic types, which are indicated by the skulls. They are defined as *Rhopalodon* (Fischer, 1841), and *Deuterosaurus* (Eichwald, 1848). Kutorga had previously founded *Brithopus* on the distal end of a humerus; *Orthopus* on the proximal end of a humerus; and *Syodon*, which was based upon a tooth. Fischer, in 1847, separated *Dinosaurus* from *Rhopalodon* by dental and cranial characters. It is probable that the separation was based upon sufficient evidence. And, although there is no conclusive association

of parts of the skeleton to support the reference, it seems to me not improbable that *Brithopus* is identical with *Deuterosaurus*; that *Orthopus* includes *Syodon* and the type of *Rhopalodon*, while the remainder of *Rhopalodon* corresponds with the genus *Dinosaurus*, as conceived of by Fischer.

Of the vertebræ, the cervical, earlier dorsal, and caudal regions of the column are unknown; but the later dorsal and sacral regions are like those of African Theriodonts, as is shown by specimens which I obtained in Cape Colony, and the evidence at present available shows no difference between them of more than generic type, unless it be in the sacral region, except in articulation with the ribs.

The pelvis in Russian fossils indicates at least three types, and the remains might be referred to as many genera. The pelvis figured by Eichwald is distinguished by the slender form and apparently small size of both pubis and ischium, which are separated from each other in a way not seen in any other specimen, which may be Pliosaurian. This type I regard as Deuterosaurian. A better preserved type, attached to the sacrum, has the first sacral rib not unlike that of *Pareiasaurus*, though relatively smaller. The ilium has the antero-posterior development seen in South African Theriodonts, but a posterior wing, for attachment to the ischium, widens the bone in a way that distinguishes it. This type may belong to *Deuterosaurus*.

In another type the three pelvic bones are anchylosed together, and there is a not inconsiderable obturator foramen below the acetabulum. This is probably Rhopalodont. There may be another generic type of ilium, marked by having a notch on its visceral surface where the sutures for the pubis and ischium meet.

These pelvic bones may be referred to the animals indicated by the skulls named *Deuterosaurus*, *Rhopalodon*, and *Dinosaurus*; but reference to each genus is necessarily wanting in the certainty which association would have given.

The shoulder girdle is known from nearly complete examples and indicates two types. No evidence of a clavicular arch is preserved.

The bones of the hind limb, especially the femur, show differences in size, which may indicate large elevated hind limbs for *Deuterosaurus*, and relatively shorter hind limbs for *Rhopalodon*. The long limb-bone figured by Eichwald (*loc. cit.*, t. 57, fig. 28) may be the radius of a large species of *Deuterosaurus*.

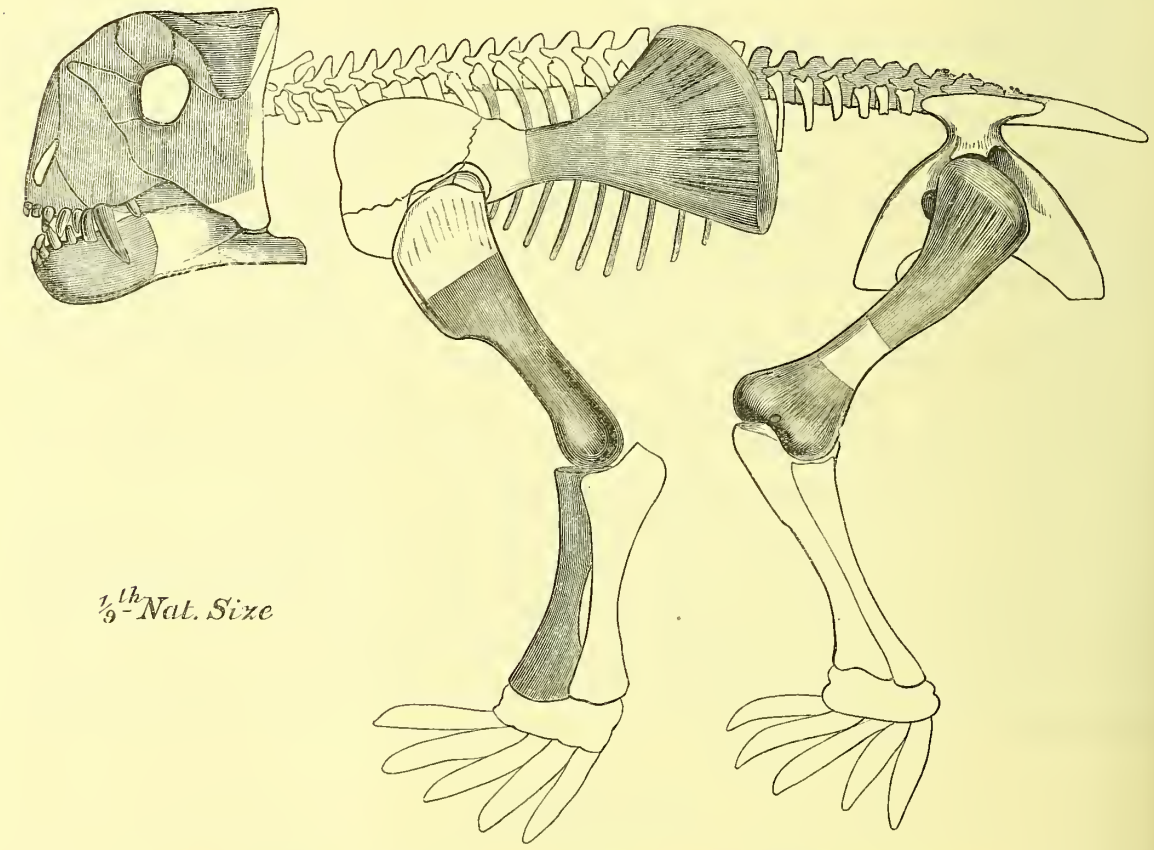
The following characters define these Russian genera as they were first instituted. Each genus includes several species.

Deuterosaurus.

Deuterosaurus is figured by Eichwald as having the upper jaw flat at the side, with the sides converging superiorly, and said to be 3 inches wide, though all Eichwald's measurements in this species are slightly in excess of the dimensions of his drawings. The lower jaw is remarkable for its almost hemispherical symphysial convexity, with obliteration of the suture between the rami, and a pitting of the

convex surface by small blood vessels, recalling the Theriodonts which I obtained in South Africa. The upper jaw shows no such anterior convexity, and the anterior nares appear to be at some height above the alveolar margin. It is not certain what was the number of teeth in each jaw. The distinctive feature of the genus is the large size of the incisors, which are compressed from side to side, and worn down by use. They appear to number five in the upper jaw and four in the lower jaw, in each side. There is a canine in each jaw. The lower canine passes in front of the upper canine, which, like the tusk of *Dicynodon*, is well behind the premaxillary suture. There are two or three teeth in front of it. The canine does not appear to have been exceptionally large. It is followed, at a larger interval than separates the incisors, by a single molar, that in the upper jaw being much wider than the molar in the lower jaw. There is no evidence of more than the one molar tooth.

Fig. 1.



Skeleton of *Deuterosaurus*. The shading indicates the bones which are known.

The remains which I refer to *Deuterosaurus* include :—

The jaws (Eichwald 'Lethæa Rossica,' 1860, t. 58, figs. 1, 2).

The skull (now figured).

Articular end of mandible (VON MEYER, 1866, 'Palæontographica,' Bd. 15, t. 16, figs. 6, 7).

Dorsal ribs (EICHWALD, *loc. cit.*, t. 59, fig. 3).

Lower dorsal and sacral vertebræ (EICHWALD, *loc. cit.*, t. 59, figs. 1, 2).

Scapula (EICHWALD, *loc. cit.*, t. 57, fig. 26).

Humerus, proximal part (TRAUTSCHOLD, 1884, 'Soc. Imp. Nat. Mosc.,' tome 15, t. 5); distal end (KUTORGA, 1838, t. 1, fig. 1) = *Brithopus*.

Radius (EICHWALD, *loc. cit.*, t. 57, fig. 28).

Pelvis, young specimen (EICHWALD, *loc. cit.*, t. 57, fig. 30); old specimen (VON MEYER, *loc. cit.*, t. 17, fig. 3); specimen now figured with sacrum.

Femur, proximal end (TRAUTSCHOLD, *loc. cit.*, t. 6); distal end (EICHWALD, *loc. cit.*, t. 59, fig. 4); VON MEYER, *loc. cit.*, t. 19, figs. 1, 2, 5).

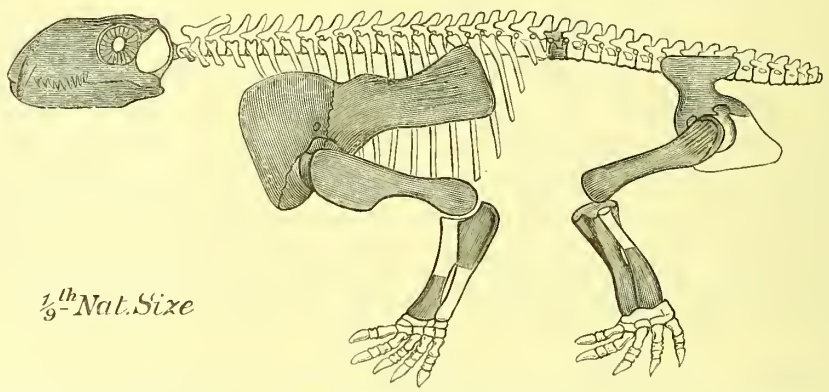
There is probably more than one species of *Deuterosaurus*. It seems to me not improbable that the remains referred by TRAUTSCHOLD to *Oudenodon* may be assigned to the skull of *Deuterosaurus*, in so far as I can judge from the opportunity of studying the very fragmentary remains, for which I am indebted to Professor ALEXANDER STUKENBERG, of Kazan, and the kind offices of Dr. A. KARPINSKY and M. FRIEDRICH SCHMIDT, of St. Petersburg.

Rhopalodon.

Rhopalodon was founded upon a lower jaw which contained small club-shaped teeth, characterized, according to FISCHER, by having the root contracted below the enamelled surface of the crown. Two species were defined. One, *R. Wangenheimii*, was said to have serrations on the hinder margin of the tooth, and the other, *R. Mantelli*, had no serrations at all. I am disposed to believe that absence of serration on the anterior border of the tooth is rather comparable to the condition of the lower jaw teeth in *Megalosaurus*. The maxillary teeth in that genus are perfectly serrated along both borders, from the summit to the base of the crown; while in the mandibular teeth the serration is complete on the posterior border, but only found at the summit of the crown on the anterior border. The transverse expansion of the tooth in *Rhopalodon*, is probably a good generic character; and this, with the limitation of the serrations of the lateral margin of the crown may be sufficient to define the genus *Rhopalodon*. It unfortunately happens that nothing more is known of the skull of *Rhopalodon*, as thus defined; and it is possible that it may present a closer correspondence with the type originally named *Rhopalodon Murchisoni* than was recognised by FISCHER. EICHWALD, indeed, grouped *Dinosaurus Murchisoni*, as FISCHER's third species, with *Rhopalodon*; but this arrangement involved a reference to the same genus of species in which the crown of the tooth is serrated on one or on both borders; and in which the root is not conspicuously

narrower than the crown, and in which the crown is transversely expanded. It is a question of the value of generic characters.

Fig. 2.



Skeleton of *Rhopalodon*. The shading indicates bones which are known.

The remains which I refer to *Rhopalodon* include :—

The skull (now figured).

The mandible (Eichwald, *loc. cit.*, t. 58, fig. 9 ; Fischer 'Bull. Mosc.,' 1841, t. 7, fig. 1).

A dorsal vertebra (von Meyer, *loc. cit.*, t. 15, figs. 1–4).

The scapular arch (von Meyer, *loc. cit.*, t. 18, figs. 1 and 2 ; t. 20, figs. 1 and 2).

The scapular arch, now figured, belongs to a species of *Rhopalodon* or to *Dinosaurus* if that genus is distinct.

Humerus (proximal end, Kutorga, *loc. cit.*, = *Orthopus* ; proximal end, von Meyer, *loc. cit.*, t. 16, fig. 2 ; distal end, von Meyer, *loc. cit.*, 15, figs. 5 and 7).

Ulna, proximal end (now figured).

Metacarpal bone (Eichwald, *loc. cit.*, t. 58, fig. 12).

Pelvis, now figured (imperfectly known).

Femur (Eichwald, *loc. cit.*, t. 59, fig. 5 ; specimen now figured).

Tibia (von Meyer, *loc. cit.*, proximal end, t. 21, fig. 9 ; distal end, t. 20, fig. 6).

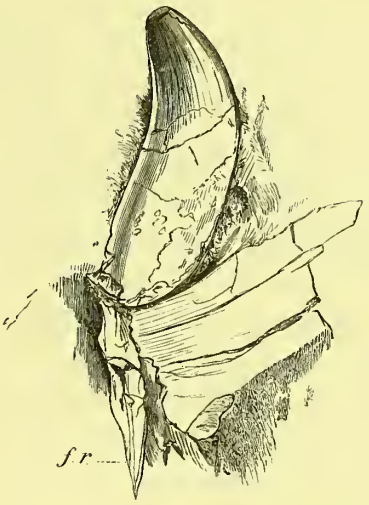
Fibula (Eichwald, *loc. cit.*, distal end, t. 57, fig. 29).

Dinosaurus.

Dinosaurus Murchisoni rests upon a type figured by Fischer, and subsequently by Eichwald. Fischer's figure appeared in 1847. Eichwald in 1848 gave an anterior view of the skull, showing the position of the great maxillary canine ; and he subsequently gave a lateral view of the same specimen, which shows a portion of the skull and the lower jaw. The teeth in the skull are all broken ; but are manifestly of large size, and essentially conical in character. Six occur in the space

of 2 inches. FISCHER had figured the same teeth as occupying $5\frac{3}{10}$ inches of the alveolar border, representing them as in close contact; while EICHWALD shows a slight interspace between them. These are maxillary teeth. The lower jaw below them is from $1\frac{3}{10}$ inch to $1\frac{1}{2}$ inch deep behind. The lower jaw is figured separately, and shown to have seven teeth in a length of $1\frac{1}{2}$ inch, to be $1\frac{2}{10}$ inch deep towards the anterior fracture, and not much more than 1 inch deep towards the posterior fracture. The lower jaw teeth are very much smaller than those of the maxillary bone, and the separate mandible in which the teeth are preserved is apparently less deep than the lower jaw, which is in contact with the skull fragment. There is no evidence of a tusk in the lower jaw, so that it is probable the species *R. Fischeri*, which EICHWALD states is characterized by the lower jaw being armed with a great curved tusk, may belong to another genus. That author figures another specimen

Fig. 3.



Crown of tooth and (*f.r.*) fractured root in a fragment of jaw. Probably *Dinosaurus;* nat. size. Institute of Mines, St. Petersburg.

which shows the bones of the palate behind the tusk, seen from the superior surface in the interior of the skull, which indicates a type of skull less compressed from side to side anteriorly than might have been anticipated. Thus, while the transverse measurement over the posterior expansions of the transverse bones is 4 inches, the measurement over the palate in the position of the great tusks, 5 inches further forward, appears to have been $3\frac{1}{2}$ inches, as indicated on the right side of the median line. The palato-nares appear to be shown as long oblique vacuities, which diverge outward as they extend backward from between the tusks, which are separated by a pair of bones forming a narrow longitudinal bar, presumably the vomera. EICHWALD has figured small teeth on the hinder border of the transverse bone on the left side. The vertical depth of the transverse bone seen from behind is fully 2 inches as figured. EICHWALD has also figured a specimen of lower jaw (plate 58, fig. 4) which is referred

to this species, but the form of the jaw appears to be different; its teeth have large conical crowns, of which three are contained in the alveolar length of 1 inch, but the jaw beneath them is only $1\frac{3}{10}$ inch deep, so that it seems to me impossible that this specimen can be referred to the same species as the lower jaw, which is represented on the same plate in fig. 9. It is probably a *Dinosaurus*, but referable to an undescribed species. *Dinosaurus*, if it is generically distinct from *Rhopalodon*, belongs to the same family, and this may account for the absence of distinctive limb bones of a third type, though the femur appears to be distinct.

The interesting species which Mr. Twelvetrees has figured as *Cliorhizodon orenburgensis*, if distinct from *Dinosaurus*, must be based upon the presumed existence of incisor teeth which have not been recorded in *D. Murchisoni*. No generic characters are enumerated by the author, and there is no proof that *Cliorhizodon* can be separated from *Dinosaurus*.

The Skull of Deuterosaurus (Plates 60 and 61).

Eichwald figured and described the anterior portion of a large skull, with the corresponding portion of the lower jaw, which is the type of *Deuterosaurus biarmicus*. It is distinguished by great vertical depth of the head, relatively to the width of the palate. And the incisor teeth, which are exceptionally large, are remarkable for the antero-posterior depth of crown and root from within outward, greatly exceeding the transverse width. The front teeth are worn flat with use in the type specimen; but the lateral teeth are unworn. Isolated teeth of large size, referable to *Deuterosaurus*, have been figured by Trautschold and Twelvetrees, which are unworn. Eichwald enumerates fourteen teeth in the upper jaw, and twelve in the lower jaw: I believe this to comprise the entire dentition. There are said to be five incisors in the upper jaw, and four in the lower jaw. There are large canine teeth in both jaws: and the inferior canine is in front of that in the upper jaw. Behind the canine tooth, separated from it by an interspace, is a single molar tooth, which is relatively small, and smaller in the mandible than in the maxillary bone.

This type of dentition is distinct from that of *Rhopalodon*, in the transverse compression of the incisor teeth, in their large size, and probably in attrition with use; in the presence of canine teeth in the lower jaw; and in the remarkable reduction in number of the maxillary teeth, which are unlike those of *Rhopalodon* in form and character.

From Eichwald's figure it might be inferred that three posterior incisors and the canine are in the maxillary bone; this appearance however results from a squamous overlap of the premaxillary by the maxillary, which covers much of the premaxillary bone.

The new skull now to be described, preserved in the Museum of the Institute of Mines, St. Petersburg, is unfortunately imperfect, and distorted. The alveolar

margin is broken away, and the region of the incisor teeth and anterior nares, which is so well shown in EICHWALD's fossil, is here worn and lost. The whole of the bones of the occipital plate are lost with the counterpart slab of rock, but their impressions at the back of the head indicate the forms of the constituent bones, and some important points of structure.

In this absence of the distinctive characters of the incisor teeth, the identification of the fossil with *Deuterosaurus* rests upon the form of the skull, the presence of a single maxillary tooth behind the large canine on the right side, and the presence of broken roots of incisor teeth in advance of the canine. The incisors were broken before the fossil was imbedded in the marine stratum from which it was obtained. Two of these roots are evident, and the third is not improbably present, leaving only the great incisors from the front of the jaw as unindicated. The anterior border of the premaxillary bones below the nares is manifestly lost, so that the front premaxillary teeth are necessarily missing. In the absence of the distinctive specific character which those teeth may give, there is no proof of specific identity with EICHWALD's fossil; but I prefer for the present, in the absence of evidence of specific difference, to refer it to *Deuterosaurus biarmicus, loc. cit.*, Plate 58, figs. 1, 2.

The most striking features of the skull are its great vertical elevation, and side to side compression, which makes the palate a long triangle, narrow in front; with a large circular lateral orbit, and transversely ovate superior temporal vacuities, which are separated by a strong parietal crest.

The vertical height of the head as preserved is 10 inches, and was originally more. Its length may be extended by compression. As preserved, the skull is $11\frac{1}{2}$ inches in length, and originally it was probably an inch or two longer. The transverse width of the palate in the region of the pterygoid bones is $4\frac{1}{2}$ inches, but the width of the occipital plate was much more; the transverse measurement in the premaxillary region is $2\frac{1}{2}$ inches. It is the highest and most compressed skull of a fossil reptile which is known.

The face is flattened in lateral aspect, but is very slightly concave between the orbit and premaxillary region. It comprises the usual bones. First, a frontal, above the orbit, with the rugose prefrontal in front of the orbit, and the post-frontal forming a narrow posterior boundary to the orbit. There is an immense lachrymal bone, which extends forward as far as the skull is preserved, in a long wedge, with much the same form as is attributed by VON MEYER to the malar bone in *Placodus hypsiceps.** At the superior suture it is 4 inches long, and it is more than $5\frac{1}{2}$ inches long at the inferior suture.

This bone forms the lower half of the anterior part of the contour of the orbit for the eye, but its slightly convex raised anterior wedge-shaped prolongation has the aspect of being a superficial scale, which rests upon the surface of the maxillary bone,

* 'Palæontographica,' vol. 11, 1863, Plate 24.

so as to divide it into a superior portion which enters into the orbit, and an inferior part which contains the teeth.

The alveolar border (Plate 60, fig. 1) of the maxillary bone (*mx.*) is broken away and lost. Its antero-posterior measurement is shown by the suture with the premaxillary, and the impression of the posterior sutural thickening, to have been about 4 inches, or less; but it is impossible to determine whether the inferior union of the palatine and transverse bones with the maxillary and malar may have been squamous. The suture with the premaxillary bone is straight and vertical, and the depth of the bone in this position, as preserved and exposed, is about 8 inches.

The premaxillary bone (*pm.*) in front of this suture is imperfect, and only remains as a narrow strip not more than $1\frac{1}{8}$ inch wide as preserved. No portion of its anterior border is preserved. Its vertical height to the superior fracture is about $5\frac{1}{2}$ inches. On the palate these bones meet in a median suture, and have an antero-posterior extent of $2\frac{1}{4}$ inches. They are almost embedded in the maxillary bones, which extend above them laterally, so that, although the suture between the maxillary and premaxillary bones is $1\frac{1}{2}$ inch in advance of the canine tooth, the premaxillary bone abuts closely against the socket for that tooth. This shows that the suture does not depart materially from its usual position, and, although the anterior extremity of the bones is imperfect, the snout has much the same side to side compression and form as is shown in EICHWALD'S figure.*

The prefrontal bone (*prf.*) appears to be defined from the frontal by a vertical or nearly vertical suture, which passes from the crown of the head outward to the orbit. Its anterior border is broken away with the compression which has affected the right side of the head; and the superior suture defines this bone as apparently wedge-shaped, with a narrow border on the orbit, and a wide border on the nose, which appears to have been more or less flattened in front, and obliquely inclined from above downward. Its surface towards the orbit is rugose with irregular groovings which cross each other, and somewhat mask the sutures, though its lower external part is flat, and marked with small vascular perforations. The width of the prefrontal at the orbit is about $1\frac{1}{4}$ inch, and it extends obliquely upward for about 3 inches to the superior fracture.

The frontal bone (Plate 61, fig. 1) (*f.*) has its chief extension behind the orbit, and makes not more than an inch of the margin of its upper arch. It has a straight sutural union with the post-frontal bone (*pt.f.*) which extends at the back of the orbit. These two bones have a smooth superior external surface, which is convex from above downward, concave from within outward; and they form the anterior boundary of the post-orbital vacuity of the cranial region. Those vacuities are separated by the median parietal crest, but there is no evidence whether they were arched over with bone superiorly, for the summit of the parietal ridge is broken, and the post-frontal is imperfect posteriorly. The form of each frontal bone on the roof of the skull appears

* 'Lethæa Rossica,' Tab. 58, fig. 2.

to be triangular. It unites posteriorly with the post-frontal bone by a suture $3\frac{1}{4}$ inches long which is indented by the narrow parietal bones in the median line; and it is defined laterally by a straight suture with the prefrontal bone, which passes inward as it extends forward. Its anterior limit is not definite, but its antero-posterior extent appears to have been about $3\frac{1}{2}$ inches.

The nasal bones (*n.*) are too imperfectly preserved for description; but were manifestly narrow, extending between the maxillary bones, and in advance of the frontal bones to the anterior nares. The forms of those vacuities can only be gathered from Eichwald's figure ('Lethæa Rossica,' Plate 58, fig. 2). In the fracture at the extremity of the specimen now described, the external nasal vacuity appears to be 3 inches deep as exposed.

Behind the orbit (*o.*) the post-frontal bone (*pt.f.*) joins the parietal bone (*p.*) above (Plate 61, fig. 1) as well as the malar bone below (*mr.*), though its extension inferiorly below the orbit is partly broken away; and much of the extension of the malar and post-frontal bones is only indicated by the internal moulds or impressions from which the bone-substance is lost. There is an indefinite appearance of a dismemberment of the post-frontal bone, in the middle of the posterior orbital border, which may indicate that the bone which meets the malar should be regarded as the post-orbital.

The orbit (Plate 60, fig. 1) is only preserved upon the left side, where it is regularly ovate, and measures $3\frac{1}{4}$ inches in depth, and $2\frac{3}{4}$ inches in width. Its superior border is thickened and convex, and rugose with channels, while the inferior border has the bones compressed and comparatively thin. The bones which enter into its margin are described as the malar, lachrymal, maxillary, pre-frontal, frontal, and post-frontal, and possibly the post-orbital. It is behind the middle of the length, and above the middle of the depth of the skull, vertical, and inclined slightly forward.

The malar bone (*mr.*) is almost entirely broken away, and is seen to have been almost as thin as the hinder part of the maxillary bone, which it overlaps by squamous suture. What remains of the sutural line is sinuous as it extends downward from the orbit. Its inferior border is horizontal, and unites by suture with the palatine bone anteriorly and with the transverse bone behind, so that on both sides the malar bones converge as they extend downward to the palate; and the inferior border is concave from front to back, as is proved by an impression from a mould of the external surface (Plate 60, fig. 3) preserved with the skull.

The vertical depth of the arch behind the orbit, which makes the external boundary of the temporal vacuity, may not greatly exceed 3 inches. The skull is somewhat imperfect in this region, but it is clear, from comparison of the right and left sides, that there is a continuous extension of bone backward from the maxillary to the quadrate bone (*q.*), much as in *Placodus*; only *Deuterosaurus* has this post-orbital plate notched out on its superior border, behind the orbit, so as to expose the lateral aspect of the brain case (Plate 60, fig. 1). The suture which limits the post-frontal or post-orbital below is clearly seen. Its hinder extremity meets the

squamosal (*sq.*) which partly envelopes the quadrate bone (*q.*), as in Anomodonts, extending over it in front. In the angle between the squamosal, post-frontal, and malar is a thin plate of bone, which can only be identified with the quadrato-jugal (*qj.*). It forms the external palatal border to the temporal vacuities, which have the same transversely ovate form on the palate as on the superior aspect of the skull.

The palate, as preserved, is about 9 inches long. It is closed in the median line, and remarkably concave from front to back (Plate 60, fig. 3). It is conditioned, as in *Megalosaurus*, many Lizards, and Chelonians, in having a thin alveolar margin to the jaw, which descends nearly an inch below the surface of the vaulted palate. The contour of the palatal aspect of the skull, seen from the under surface, is triangular, with the lateral borders flattened, and inclining to concavity, as they converge forward from the transverse infra-occipital plate. The premaxillary bones descend anteriorly in a solid mass like a beak, which is not paralleled in any South African Theriodont, and is different from the condition in *Hyperodapedon Gordoni*, where the beak is chiefly formed by the premaxillary teeth, and the character is not manifest in the figure of EICHWALD'S original specimen.

The teeth in this skull are badly preserved. They have an aspect of being broken and worn previous to fossilization. There may be indications of transverse sections of the ovate roots of three incisors placed laterally; and in front of them is possibly a section of another and larger incisor root, with space for a fifth, in a position nearer to the median premaxillary suture, though no portion of the root is preserved. Hence the number of incisor teeth may be the same as EICHWALD'S type; though the indications are so obscure that they might have escaped notice, if EICHWALD had not figured two incisors in advance of the maxillary suture, and three incisors behind it; still the incisors in his specimen are relatively larger, as though the crowns might be different.

Immediately behind the premaxillary bones is a pair of large and long canine teeth (Plate 60, fig. 2*c.*), contained in the maxillary bones. The antero-posterior diameter of the root is about 1 inch, becoming less as it ascends. The crown is strong, ovate in section, compressed from within outward, serrated on the hinder border. It has $2\frac{1}{2}$ inches of its vertical extension below the palate (*cn.*) preserved, without an appreciable decrease in size at the inferior fracture, where it is seen to have an ovate pulp-cavity of moderate size. The root of the tooth (*r.*) in the maxillary bone is conical; and the extreme length indicated for root and crown on the right side is 4 inches, as preserved. The enamel surface, as evidenced by a portion of the impression of the crown, is smooth and shining. The distance of the anterior border of the teeth, behind the anterior extremity of the snout as preserved, is $2\frac{1}{2}$ inches. The teeth diverge outward as they descend. They are as remarkable for the diameter (1 inch), exceeding the diameter ($\frac{5}{8}$th inch) of the canine in EICHWALD'S specimens, as the indications of incisors are for showing that the incisors in this fossil are much

smaller than in EICHWALD'S type, which shows no such anterior descending development of the premaxillary bones.

Behind the canine, separated by an interspace of less than $\frac{1}{2}$ inch, is the single molar tooth (Plate 60, fig. 2*m*.). In EICHWALD'S specimen this interspace measures $\frac{3}{4}$ inch. The tooth is relatively small, with the root strong, ovate in section, measuring $\frac{4}{10}$ inch from front to back. The crown is short, convex, of conical aspect, enamelled, smooth, widened transversely a little beyond the root, and terminating laterally in a sharp margin, so that the inner side of the crown was less convex. The height of the enamelled part of the crown, $\frac{7}{20}$ inch, is about equal to its antero-posterior extent. There is no indication of a second molar.

These dental characters confirm the reference of the genus to *Deuterosaurus*, but not improbably show that the species is different from that described by EICHWALD.

The bones shown upon the palate, in addition to the premaxillary and maxillary, are the vomera, palatines, transverse bones, and pterygoid bones, all of which, except the palatine, transverse, and possibly the maxillary, meet in the median line. There are two pairs of vacuities in the palate; first, the palato-nares, which are between and behind the canine teeth; and secondly, the temporal vacuities, which are imperfectly defined, but are external to the pterygoid bones.

Between the canine teeth the transverse measurement is $1\frac{1}{2}$ inch. The space anteriorly is occupied by the premaxillary bones in the way described; and then the maxillary bones may meet mesially and extend backward between the palato-nares, overlapped upon the palate by a pair of bones which are regarded as vomera. The transverse width of the longitudinal bar which they form does not exceed $\frac{1}{2}$ inch. The passage of the palato-nares downward and backward, on each side of it, causes them to open as long vacuities widest behind, where the contours are well rounded. The limits of the vomera (Plate 60, fig. 3, *v*.) are indistinct, but they terminate forward in a transverse suture which is behind the narrowest part of the waist of the palatal ridge. They are continued backward as a pair of bones which form an irregular pentagon, widening posteriorly by the longer concave borders, which form the inner and hinder borders of the nares, meet the palatine bones laterally, and the pterygoid bones behind.

The palato-nares (fig. 3, *pt.n.*) are distorted with compression of the skull. That on the right side appears to be fully 2 inches long, and that on the left side is $\frac{8}{10}$th inch wide posteriorly. The vomerine bones are $1\frac{1}{2}$ inch wide, where widest, at the back of the vacuity, and are about $\frac{1}{2}$-inch wide at their anterior junction with the premaxillary or maxillary bones. These bones form a longitudinal, median, narrow-rounded, palatal ridge, which is prolonged backward on to the pterygoid bones. This median ridge is flanked on each side by a concave groove, which widens as the palatine bones extend backward. The grooves are defined by lateral ridges, limited to the vomerine bones, diverging as they extend backward, and less prominent than the median ridge. This area of the palate is deeply concave from side to side,

between the palatine bones (*pn.*), which descend on each side, as well as concave from front to back. The palatine bone (*pn.*) meets the maxillary (*mx.*) in front, behind the alveolar border. Internally it joins the vomer (*v.*) and pterygoid bones (*pty.*) and meets the transverse bone (*t.*) by a transverse posterior suture, while the malar bone (*mr.*) joins its lateral superior margin. Each bone forms an elevated lateral ridge, rounded from side to side, diverging outward as it extends forward, and concave in length. In general character it resembles the transverse bone of a Crocodile, though it is relatively larger, and is especially distinguished by its elevated position upon the palate. The pterygoid bones form the deep longitudinal depression between the transverse bones, which is divided by the small median palatal ridge. Outward and backward behind the pterygoid (*pty.*) are the transverse bones. The pterygoid bones in front are $1\frac{1}{4}$ inch long, with a transverse width of $\frac{3}{4}$ inch. There is no evidence that the pterygoids were in squamose contact with the quadrate bones, though they may be presumed to have had this union, for there is a continuous extension of bone from the pyterygoid at the back of the base of the palate, transversely outward to the quadrate region from which the bone is lost. It is only represented by an impression of the anterior surface of the transverse bone. There is a faint indication of what appears to be a smooth sutural border to the pterygoid on the inner margin of the quadrate, which is suggestive of the condition in *Dicynodon*, though the pterygoid was developed backward in a way which is more Theriodont.

At the back of the palate there is a pair of transverse lateral vacuities which are deformed with the compression of the skull. That upon the left side is oblique, extending outward and backward. As preserved, it is about $3\frac{1}{2}$ inches long by $2\frac{1}{2}$ inches wide. It is bordered by the transverse bone on the inner side, by the quadrate bone behind, with the quadrato-jugal, and possibly the malar bone in front; but the cast is not complete below the orbit, so that the continuity between the malar, and what appears to be the quadrato-jugal, is lost. It is apparently found by means of an impression from the external surface of the palate which may be superimposed upon the base of the skull, so as to show that the malar formed the wall of this vacuity above the pterygoid in front, but the suture between the malar and quadrato-jugal is not seen, though it is distinctly preserved between the malar and post-orbital bones beneath the orbit. These vacuities are the inferior openings of the superior temporal vacuities behind the orbits, which are vertically above them, of transversely ovate form, 2 inches from front to back externally, and $2\frac{1}{2}$ inches in transverse measurement. The transverse measurement from the median line of the palate to the outer extremity of the impression of the quadrate bone is $4\frac{1}{4}$ inches, so that the palate appears to have been fully 8 inches wide posteriorly, and about a foot long.

The back of the skull appears to have been a vertical plate of bones, with the foramen magnum placed above the middle, and the superior contours converging upward

to the parietal foramen. Its right side is crushed, but the transverse measurement on the left side is $4\frac{1}{2}$ inches from the median line, so that across the vertical external borders of the quadrate and squamosal bones the width exceeded 9 inches. The height at this external border, which gives no indication of the quadrate condyle, is $4\frac{1}{2}$ inches; and the height in the median line to the worn parietal crest exceeds 9 inches, and about an inch may be lost. Most of the bones from the back of the head are lost with the counterpart rock (Plate 61, fig. 2). This fracture has exposed the neural cavity below the parietal foramen. The cavity of the pineal canal is a vertical stalk, ascending for fully $2\frac{1}{2}$ inches above the mass of the brain. This pineal stalk (*p.s.*) is somewhat contracted towards the base, is $\frac{3}{4}$ inch wide in the middle, and again contracts a little from side to side towards the summit, where it becomes narrower from front to back. Its form when seen from above is transversely ovate, with a slight compression in front at the superior fracture, where it is $\frac{7}{10}$ inch from side to side, and $\frac{11}{20}$ inch from back to front. Its anterior border lies in the parietal bones, which are exposed on its borders in the posterior fracture, and shown to be encased almost to their summit in the post-frontal bones. There appears to be the impression of a median vertical suture on the posterior side of the pineal stalk; it may be regarded as formed by the parietal bones. The height from the base of the brain case to the summit of the stalk is $4\frac{1}{2}$ inches. The back of the cast of the brain is imperfect, and the cerebral cavity is filled with a small bivalve shell, which I regard as *Modiolopsis Pallasi*, in such numbers as to suggest that they may have lived there after the skull had reached the Permian sea-bed. From the indication of the posterior contour of the brain case which is preserved, the foramen magnum appears to have been large, triangular, and as wide as high, but since no portion of its margin is preserved, no measurements can be given. There is a lateral expansion of the brain case seen upon the left side, towards the junction of the parietal with the squamosal and, apparently, the ex-occipital bones, which is presumably in the cerebral hemisphere. The occipital condyle is lost with the bones at the back of the head. The height of the brain cavity to the base of the pineal stalk is about 2 inches.

Below the foramen magnum (*fm.*) there is a continuous sheet of bone, which extends vertically downward to the back of the palate, and laterally to the quadrate and squamosal bones. Theoretically this area should comprise the basi-occipital and basi-sphenoid bones, and it thus appears as though owing to the inferior position occupied by the squamosal and quadrate bones, the basi-occipital and basi-sphenoid had become developed so as to fill in the entire interspace between the pterygoids and quadrate bones. The state of preservation does not make definition of the bones obvious, but the great width of the basi-occipital appears to be evident, and was not less than 4 inches. There is no indication of a tranverse division in the plate, so that it may be $4\frac{1}{2}$ inches deep, though it is possible that the inferior part may be made by the basi-sphenoid after the manner of Teleosaurs, or Chelonians. I am acquainted with no other fossil in which the occipital plate is formed in this way. On the right

side, a well-rounded convexity diverges downward and outward from beneath the brain cavity towards the quadrate bone, and a narrow ridge appears to descend vertically to the median line of the palate; and external to this ridge, the bone surface is flattened, but is a little concave.

The squamosal bone, Plate 61, fig. 2 (*sq.*) although only known from the impression, is at a lower level in the skull than is usual in Saurians. On the posterior aspect it is somewhat flattened, and of an irregular triangular form. It meets the supra-occipital, ex-occipital, and basi-occipital bones on the inner side, though they are ill defined, and the quadrate bone below; the superior border of the bone inclines downward and outward. On the lateral aspect the bone bends round sharply, and descends in front of the quadrate, meeting what appears to be the quadrato-jugal bone. Its superior border is on about a level with the base of the orbit. The quadrate bone, Plate 61, fig. 2 (*q.*) as preserved, is slightly exposed laterally, but is chiefly seen at the back of the skull, where it is vertically oblong and has a convex surface. It is nearly 2 inches wide below the squamosal bone (*sq.*) and $2\frac{1}{2}$ inches wide at the inferior fracture. It is $3\frac{1}{4}$ inches high as preserved; but the condyle, which is lost, may have made the bone an inch longer. The posterior surface extends convexly on to the lateral aspect of the bone as preserved. In general form the quadrate bone appears to be quite as much like that of a Plesiosaurian, such as Murænosaurus, as Dicynodon; and its position and large size are unlike African Theriodonts.

The skull which at first sight suggests comparison with this fossil is the South African *Delphinognathus* ('Quart. Jour. Geol. Soc.,' vol. xlviii., p. 569), in which the head is compressed, with a large orbit, a vertical occipital plate, large parietal foramen, and a similar zygoma. But the affinity is probably not very close. The parietal region in *Delphinognathus* does not form a crest; the parietal foramen is not at the back of the head, the temporal vacuities are relatively small, the quadrate bone is not vertical, and the maxillary bone does not appear to form a deep vertical plate; while no canine teeth or incisors are yet known in *Delphinognathus*, and the bones cannot at present be individually compared. Still the resemblances indicate affinity, and suggest the possibility of both types being referred to the same order of animals, and that there may be community of structure with the South African Theriodonts in other parts of the skeleton. Sir Richard Owen, in 1876, fully demonstrated the close resemblance in dentition between *Deuterosaurus* as figured by Eichwald, and the South African Genera *Cynodraco* and *Lycosaurus*, and in the latter genus there are indications of a strong though broad parietal crest. In *Gorgonops* the parietal foramen is almost as far back. In all these types however the structure of the palate is different, and no African genus has given evidence of palatine and transverse bones and pterygoids, conditioned as are those bones in *Deuterosaurus*; while the back of the skull differs in the remarkable developement of the region below the occipital condyle.

There is in the European Muschelkalk genus *Placodus*, as represented by *P.*

hypsiceps (v. MEYER), a resemblance which may indicate affinity as close as is shown by South African genera. The skull is compressed and high, the orbit large, the temporal arch more developed than in *Deuterosaurus*; incisor teeth have much in common; though there are no canines; and the palatal teeth of *Placodus* are unparalleled in the Russian fossils. The palato-nares and the pterygo-malar vacuities are the only openings in the palate. The parietal foramen which is sometimes large, is never so far backward in position, but there is much in common in the positions of the bones of the skull, in so far as they can be compared. And from such considerations *Placodus* has seemed to me to be an Anomodont which more closely resembles *Deuterosaurus* than any other European genus; but as its teeth indicate an aquatic habit, it is not improbable that the limbs differ from those of *Deuterosaurus*. On the whole, the structure of the palate and the back of the skull make it convenient to separate the Deuterosauria from the South African Theriodonts. They appear to make some approach towards the Pareiasauria, notwithstanding the differences which are obvious in the armature of the skull, in its occipital region, and the palate. Until the North American Permian Reptilia are more perfectly figured it will not be possible to determine whether the genus *Clepsydrops*, which has a Theriodont dentition and compressed skull, conforms more to the African or the Russian types. The form of the back of the head, and the structure of the palate in *Deuterosaurus* are approximations to both the Nothosauria and Sauropterygia, which, taken with the remainder of the skeleton, seem to suggest that the systematic position of this type is between the Nothosauria and the Theriodontia. The fact that *Deuterosaurus* is essentially a Theriodont Plesiosaurian in skull structure, indicates a closer affinity between the Anomodontia and Sauropterygia than has been previously evident. For the skull appears to be substantially of the same type as in *Rhopalodon*, and may be regarded as approaching in structure to Plesiosaurs, Crocodiles and Chelonians; though in dentition it is indistinguishable from the Theriodontia, as described by Sir R. OWEN. Other parts of the skeleton, supposing them to be correctly referred to this type, support the inferences drawn from the teeth.

The Articular End of the Mandible of Deuterosaurus.

Three bones were figured by VON MEYER, but not osteologically determined, which are all referable to the same part of the skeleton.

The two more important fragments are drawn in the 'Palæontographica,' t. 15, plate 16, figs. 6, 7; plate 19, figs. 4, 5. Both, unfortunately, are fractured, but their singular aspect makes identification comparatively easy. One example has been somewhat cleaned from the matrix. It shows an articular surface in the position where the bone is thickest. The articular surface is wide and short, measuring, transversely to the length of the bone, $1\frac{7}{10}$ inch; while the imperfect articular surface is nowhere more than $\frac{6}{10}$ inch from front to back. It is narrower in the middle, and

has the aspect of being wider on one side. It is margined by an elevated border, beyond which is a vertical depression or foramen, and on one of the lateral surfaces there is a very large excavation, so that the bone presents some resemblance to the shoulder girdle where the precoracoid foramen indents the scapula. But since the shoulder girdle is completely known in these animals from the Permian rocks of Russia, and since the bone which offers some resemblance to the scapula is shown by von Meyer's third figure to be very nearly complete, some other osteological determination must be found.

The only articular surface in the skeleton which is unaccounted for to which the fossil could possibly belong is the articular end of the mandible. Dentigerous jaws being known, it may not be remarkable that Wangenheim's collection includes three examples of the opposite extremity. This region of the lower jaw is unlike anything previously known to me, and unlike everything which the affinities of the animal might have suggested; but, on the whole, it is more like *Placodus* than any known Theriodont or other Anomodont. It differs from all known Anomodonts in having a heel extended behind the articulation, which rises vertically above the heel on the inner side, so that it is quite different to the form of the heel of the mandible in Plesiosaurs and their allies, and is dissimilar to the condition in *Iguanodon*. The heel has a strong median ridge, prolonged backward from the posterior angle of the articular surface. This bony ridge has a convex outline posteriorly. The narrow inferior base of the heel is flattened. There is the broken base of a coronoid process on the inner side of the articular region of the jaw. In front of the articulation the bone is compressed from side to side superiorly so as to define the coronoid process. There is a small muscular tuberosity with a slight ascending ridge in front of it, at the base of the external side, below and behind the articulation. And this may possibly represent such a sub-articular excavation as is found in *Endothiodon*. On the inner side of the jaw, chiefly behind the articulation, is a long excavation 3 to $3\frac{1}{2}$ inches from front to back, and about $\frac{9}{10}$ inch deep in the middle. It communicates with the foramen seen on the superior surface in front of the articulation. And, although it is more backward in position, it may be homologous with the pre-articular vacuity seen in the mandible, laterally in Anomodonts, *Labyrinthodon*,* and from above in *Belodon*. The depth of the jaw at the articulation is $1\frac{1}{2}$ inch. The depth, as preserved, to the fracture of the ascending process interior to the articulation is $2\frac{1}{4}$ inches. The length of the heel, as preserved, measuring from the anterior margin of the articulation, is about 3 inches. The only point in common with the South African Theriodonts is in the situation of the ascending coronoid process on the inner side of the articulation. The specimens supply a distinctive character to the skeleton in these Russian Deuterosauria.

I am indebted to Dr. F. Kinkelin for the opportunity of studying, in this country, these bones, which are preserved in the Senckenberg Museum at Frankfort o/M.

* 'Quart. Journ. Geol. Soc.,' vol. 32. August, 1876.

The Vertebræ of Deuterosaurus.

The vertebral column in the Russian Theriodonts is imperfectly known. The specimens which have come under my observation are referable to four individuals and make known the lower dorsal region and the sacrum. I have seen no evidence of either the neck or tail; and there is no demonstration of the number of vertebræ in any region of the body. The first specimen in importance is the vertebral column of which a cast was submitted to Sir R. Owen in 1845, and briefly reported upon in Sir R. L. Murchison's 'Geology of Russia in Europe,' vol. 1, p. 637. It is said to comprise twelve costal and two sacral vertebræ. They have their articular faces concealed and become shorter and broader as they approach the sacrum.

The anterior vertebræ are said by Sir R. Owen to most resemble in their compressed bodies and very strong transverse processes the vertebræ of *Palæosaurus*. On the same page it is stated that the teeth of *Rhopalodon Fischeri* are nearly allied to *Thecodontosaurus*; and a Russian humerus and femur from the Permian beds are both compared with *Palæosaurus*. These references of the Russian types to the *Thecodontosauria*, may have exercised some influence on the interpretation of the skeleton by Eichwald, and the institution of the genus *Dinosaurus* by Fischer; but I am not aware that any subsequent reference to this vertebral column occurs in the writings of Sir R. Owen. In April, 1889, by the kindness of Professor F. Schmidt, of Dr. Karpinsky, and Professor Lehusen, I had the opportunity of examining this fossil in St. Petersburg. It gives no proof that the commencement of the dorsal series is preserved. It shows ten dorsal vertebræ. There is a broken fragment of another vertebra in front, which I infer to have been dorsal, from the articulations for the rib. There are two sacral vertebræ.

This number is also evidenced in a separate sacrum (p. 683). The additional mass imperfectly preserved at the hinder extremity of the column is therefore probably caudal. Hence, I concur with Eichwald, who describes the fragmentary spinal column, 14 (15) inches long, as composed of eleven dorsal vertebræ, two sacral vertebræ, and a fragment of a caudal vertebra, and refers the fossil to *Deuterosaurus biarmicus* ('Lethæa Rossica,' p. 1611). Von Meyer does not appear to have examined the specimen, but he thinks that the number of dorsal vertebræ must be inferred to have exceeded eleven, from the evidence of the costal ribs, of which ten are preserved in the slab figured by Eichwald, without indication that the first rib is the earliest, or the last the latest of the series. The earlier vertebræ in the associated column are $1\frac{3}{20}$ inch long, but the length diminishes till in the last dorsal it is less than $\frac{9}{10}$ of an inch. The sacral centrums may be a millimetre longer. Anteriorly, the base of the centrum is rounded from side to side without a trace of infero-lateral ridges, and the sides of the centrum are compressed transversely. On the anterior upper angle of the side of the centrum, close to the articular margin in front, is placed the parapophysis.

It is well seen in the second dorsal preserved on the left side, vertically ovate in form, and separated by a notch from the pre-zygapophysis. The transverse width through the sides of the centrum is $\frac{6}{10}$ of an inch. But the transverse measurement over the parapophysis is about $1\frac{1}{10}$ inch. In the second vertebra, the transverse process is compressed from above downward, directed horizontally outward on a level with the neural canal, placed towards the hinder part of the neural arch, and expanded a little transversely at its free end. This process is 1 inch long, and fully $\frac{11}{20}$ of an inch wide. The anterior zygapophyses are in front of it, and the neural spine is chiefly developed behind it. The neural spines of all the vertebræ are more or less broken, and are conspicuously vertical, or approximate to the vertical position, rather than the backward position.

This leads me to regard them all as lower dorsal and lumbar vertebræ. They become thicker and stronger in passing down the back. As I have not been able to compare the original specimen with other fossils in this country, the following observations are based upon the cast of it, preserved in the Museum of the Royal College of Surgeons (No. 314). The sacral ribs appear to be complete, they are singularly strong, slightly contracted towards the middle, directed backward, $1\frac{6}{10}$ inch long. They are much smaller than in the new specimen presently to be described, supposing them to be complete, as they appear to be, and of different specific type.

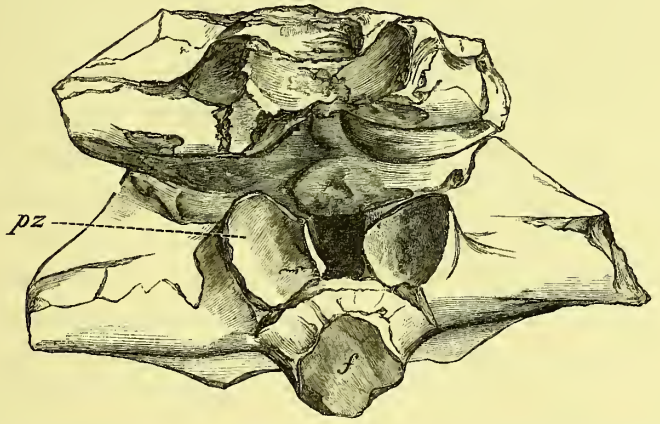
There is no evidence, from the cast, that any of the dorsal ribs are anchylosed to the centrum. In the lower part of the vertebral column the centrums are somewhat obliquely crushed, and, on the left side, the heads of the ribs appear to me to remain in contact with the neural arch, though a little displaced ; and, on the right side, the lower dorsal ribs, though imperfect, are seen to be short, slender, and flattened from above downward, from which I infer that if the ribs figured by Eichwald, *loc. cit.*, plate 59, fig. 3, belong to the same vertebral column, as he suggests, they must be referred to a position not more posterior than the first five vertebræ of the left side, so that, as the ribs are 10 in number, the specimen would appear to indicate not fewer than 16 presacral vertebræ which carried ribs which might be classed as dorsal, and the number of dorsal vertebræ may be greater, for the series of ribs shows no indication of completeness. This is in harmony with von Meyer's view that the vertebræ must have been more numerous than the vertebral column indicates. I cannot, with any probability, suggest the total number of presacral vertebræ ; it was probably not fewer than 19, or more than 26. The broad vertebræ of the lower dorsal region are 6 in number. They appear to have the ribs specially modified, so that they might be termed presacral or lumbar, rather than dorsal. I suppose the cervical vertebræ to have numbered 8, the dorsal vertebræ 12, the lumbar vertebræ 6, which would give the total of 26 presacral vertebræ. It is a characteristic of South African Theriodonts, shown by specimens which I obtained in 1889, to have the lower dorsal vertebræ specially modified, at least in their ribs, and the number of presacral vertebræ appears to be greater than in allied reptiles. The numerous vertebræ of

Nothosaurs show that *Deuterosauria* do not approach some of the allied aquatic types in length of vertebral column.

The Sacrum.

The isolated specimen of sacrum preserved at St. Petersburg may possibly belong to a different species from that indicated by EICHWALD'S fossil. It shows that the vertebræ were as deeply biconcave as in *Anthodon*, so that the concavities almost meet in the middle of the centrum; and, as in the South African types, the outer articular part of the face of the centrum is comparatively flat, which gives an appearance of extreme excavation. The two sacral vertebræ appear to be anchylosed together on the ventral border, which is somewhat thickened; but the prezygapophyses are perfectly preserved in the second vertebra, as oblique concave facets which look upward and inward. The transverse width over them exceeds an inch; an interspace of $\frac{1}{4}$ of an inch divides them, and the best preserved facet is $\frac{6}{10}$ of an inch long. The size and preservation of these facets show that the sacrum, if anchylosed, had not lost the independence of its individual vertebræ till ossification

Fig. 4.



pz., prezygapophyses. *f.*, fractured neural spine of second sacral vertebra.

and growth were well advanced. The base of the centrum is convexly rounded from side to side, and deeply concave from back to front. The whole of the side of the vertebra is occupied by the sacral rib. Both it and the neural arch are firmly anchylosed to the centrum, though the line of union of the rib can be traced. What remains of the rib to the first vertebra is relatively small and is a triangular process $\frac{7}{10}$ of an inch deep, compressed from side to side, rounded above, flattened below, with a foramen in the middle of the underside, at its junction with the centrum, but the outlet for its vessel is not seen. This process is directed transversely outward, and at the external fracture is so compressed that it may be doubted whether it could have reached the ilium, so that it may be classed as sacro-lumbar and compared

to the first vertebra in the sacrum of *Pareiasaurus*. The second vertebra has a much stronger sacral rib, the attachment for which is about $1\frac{4}{10}$ inch deep. Its antero-posterior extent is $1\frac{3}{10}$. It is directed outward and downward, flattened at the base, with the usual transverse foramen at its junction with the centrum. It is compressed above, and the channel form on its anterior side is more marked than in the preceding vertebra. The transverse measurement of the fragment is rather less than $3\frac{1}{4}$ inch.

The neural canal seen in front is small and circular, $\frac{4}{10}$ inch in diameter. The zygapophyses are strong, short processes which hang forward, so that the arch below them is concave. The base of the neural spine is sub-quadrate and inclined upward and backward. The distinctive feature of this specimen is in the angular ridge which margins the antero-superior angle of the sacral rib, which is not seen in the third example of the sacrum.

Sacrum united to the Pelvis. (Plate 62.)

The two sacral vertebræ in the specimen with the iliac bones attached are very similar in general aspect, whether seen from above or below, the difference between them being due to the great development of the sacral ribs in the first vertebra, and to the large size of the articular face of the first vertebra, which is 2 inches wide, as compared with the posterior face of the second vertebra, which is $1\frac{2}{10}$ inch wide; and as there is a corresponding diminution in depth, there is some reason for concluding that the tail of the animal was small, though no caudal vertebræ are known to be preserved. The articular face of the first vertebra is encroached upon by the sacral ribs, which contribute the lateral parts of an articular surface with the centrum in front (fig. 2, *sr.*), which is thus made concave from side to side by the inclination of the sacral ribs. The centrum presents the usual deeply excavated fish-like anterior concavity, seen in other specimens. The depth of the centrum from the neural canal downward is $1\frac{3}{10}$ inch. The width of the articular facet upon the sacral rib on each side is $\frac{6}{10}$ inch. The (*sr.*) rib is perfectly preserved on the left side, where it is seen to be directed downward, outward, and slightly backward. It is 3 inches long, measured at the base, and about a quarter of an inch longer measured in the middle. The rib is flattened in front, somewhat contracted behind its articular surface with the preceding vertebra, and impressed superiorly towards its junction with the neural arch, as though forming a channel for the sacral nerve. This impression defines the superior surface, which is transversely straight and continuous with the shoulder of the neural arch, which is similarly fully $\frac{6}{10}$ inch wide, though the bone expands transversely to half as much again at its outward termination, in an oblique truncated surface, which articulates with the ilium. This superior surface of the sacral rib is somewhat rounded from side to side, convex from above downward at its junction with the neural arch, and concave from within outward as it descends towards the ilium. The vertical depth of the rib

with the vertebra exceeds $1\frac{1}{2}$ inch, and, owing to the concave inferior contour, it contracts speedily to $\frac{9}{10}$ inch, but at the external junction with the ilium its depth exceeds 2 inches. Its inferior surface is convexly rounded, and measures about $1\frac{1}{2}$ inch from front to back externally, where its margin comes into contact with the inferior margin of the second rib. At the junction of the inferior surface with the centrum, the bone is flattened, and there is a foramen on the under side, which appears to be in the line of suture (fig. 3), and placed behind the middle of the sutural border. The right rib is somewhat depressed and distorted, but apparently a line joining the outer angles at which the ribs meet the iliac bones would pass below the middle of the centrum, and the base of the rib apparently descends to a level with the line of suture between the ilium and pubis, and its anterior margin is on a level with the anterior border of the ilium as preserved. The transverse measurement over the sacral ribs is now $5\frac{1}{2}$ inches, and appears to have been 6 inches originally. The extreme vertical distance over which the rib extends is 3 inches. The second sacral rib is similar when seen from above, except that it is narrower at its junction with the neural arch, owing to the existence of a large oblique posterior area external to the neural canal on its posterior aspect. The rib is compressed from above downward, so that in the middle it only measures about $\frac{4}{10}$ inch, but it expands outward to a depth of about $1\frac{2}{10}$ inch, and is conspicuously produced backward at its junction with the ilium, so that the antero-posterior measurement there is $1\frac{1}{2}$ inch. Seen from behind these sacral ribs have the aspect of being extended outward horizontally, and they lie almost entirely above the central pit in the middle of the centrum. Thus the second rib is very small as compared with the first. Its extreme transverse measurement on the left side from the middle of the centrum is $2\frac{7}{10}$ inch. There is no indication of a third sacral rib having been attached to the very thin posterior plate of the ilium, which is in marked contrast with the thick anterior part of the plate, $\frac{6}{10}$ or $\frac{7}{10}$ inch thick, which supports these two ribs.

The neural arch shows a transversely ovate neural canal in front of the first sacral vertebra, and a circular canal at the back of the second. The base of the arch has the aspect of leaning somewhat forward, and in the first vertebra it appears to enter with the centrum into the summit of the inter-vertebral articular surface. The anterior zygapophyses are strong, directed well forward, almost external to the neural canal, and concave from within outward (*pz.*). But the posterior zygapophyses are very much smaller, and are only separated by the width of the base of the neural spine. The transverse measurement of the former is about $1\frac{3}{10}$ inch, and of the latter about $\frac{11}{20}$ inch. The neural spines (*ns.*) are remarkably strong. The first rises $1\frac{7}{10}$ inch above the summit of the neural canal. It is inclined a little backward, and measures $\frac{13}{20}$ inch from side to side, and from back to front. It contracts a little from back to front toward the summit, and shows a short median ridge towards the base, flanked by two lateral ridges, which ascend from the pre-zygapophyses. But transversely, the bone widens towards the summit, so that the transverse measurement is $\frac{8}{10}$ inch,

owing to the formation of blunt ridges or tubercles. The second neural spine is similar, but narrower, and its summit is less conspicuously truncated.

The second vertebra shows at the hinder face of the neural spine three ridges like those in front of the first vertebra. The outer two rise from the zygapophyses, and converge as they ascend. The antero-posterior measurement in the line of the zygapophyses is 2 inches. This is exactly the measurement in the median line of the base of the centrums, which are moderately convex from side to side, and very slightly concave from front to back. In the stoutness of the neural spines, as in the form and development of the first sacral rib, there is a certain resemblance to *Pareiasaurus*, though the spinous processes are much smaller. In the mode of union of the ribs with the centrum and neural arch, there is something to suggest *Nothosaurus*. Ossification is complete, and the sutures are practically obliterated, though their position can be distinguished.

Dorsal Vertebræ.

Professor Alexander Stukenberg, of the University of Kasan, submitted to Dr. Karpinsky a small series of Permian bones, at the time of my visit to St. Petersburg, and I then made the following note on their characters.

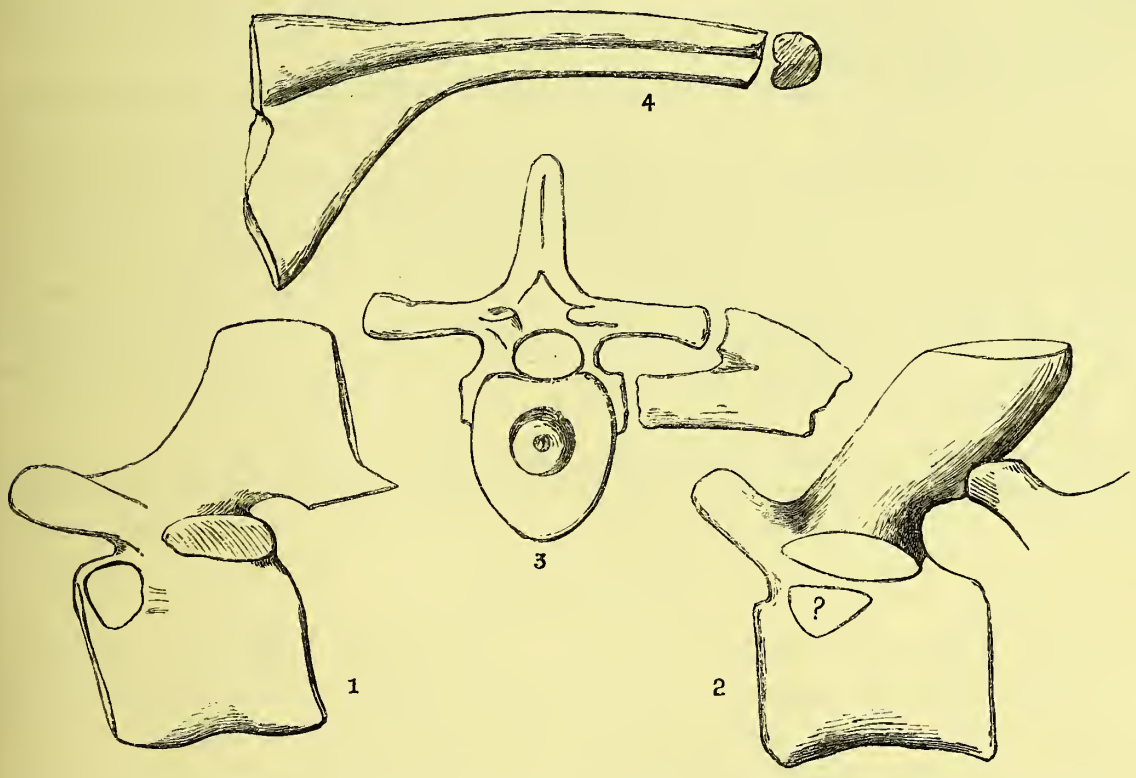
The remains consist of a series of four consecutive vertebræ from the anterior part of the dorsal region, with ribs, which give evidence of capitular and tubercular articulation; and there is an imperfect bone which closely resembles an ilium in form, but wants the superior margin, and shows a notch of small size at the angle between the two inclined articular surfaces, which are presumed to indicate the pubis and ischium. Nothing like this is seen in any of the other examples of ilium which I have examined, so that the character may indicate a new species.

In these vertebræ the centrum is $1\frac{1}{10}$ inch long. It is deeper than wide, with the base flattened, more than $\frac{3}{10}$ inch wide in the middle, slightly concave from front to back, with the basal ridges becoming stronger at the posterior end. The sides of the centrum are nearly vertical, but convex a little downward. They are concave from front to back. The articular face is vertically ovate, with a sharp margin. The posterior border is much more convex laterally, but in no case is the articular surface exposed, and there is no evidence whether it is flat or concave. The depth of the centrum is here less than its length, and equal to the width of the articular face.

The neural arch is strong, with well developed transverse processes, which extend horizontally outward, and a little backward, and expand a little in the antero-posterior direction at the free end. The process is half-an-inch long, and has a transverse extension outward, measuring from the median line of the vertebra, of one inch. The neural spine is compressed from side to side, and directed upward and backward, with the anterior border straight, and the posterior border convex, so that it widens from $\frac{11}{20}$th of an inch to about $\frac{15}{20}$th of an inch. The summit of the spine is broken, though but little appears to be lost, and its height above the base of the centrum as

preserved is $2\frac{2}{10}$th inches. The neural arch gives off strong zygapophyses, which at first have vertical facets, and afterwards have the facets horizontal. The pre-zygapophyses are directed forward and upward in advance of the transverse process; the posterior zygapophyses have the aspect of being developed from the neural spine, and, although covered by the pre-zygapophyses of succeeding vertebræ, are apparently less conspicuously developed. The summit of the zygapophysial facet is $1\frac{12}{20}$ inch above the base of the centrum. The antero-posterior distance over the zygapophyses is about $1\frac{7}{10}$ inch. Hence the vertebræ have a slender appearance when compared with the anterior vertebræ referred to *Deuterosaurus* by EICHWALD.

Fig. 5.



1. Lower dorsal vertebra. 2. Earlier vertebra. The articulation (?) on the centrum is hypothetical. 3. A *diagram* of the anterior face of a vertebra, with a fragment of a rib articulated. 4. An early dorsal rib, showing the longitudinal groove, and the deep narrow capitular articulation, which may be inter-central.

The facet on the centrum for the head of the rib is not clearly exposed. It appears to have been near to the anterior border, and may be judged of best by the figures of the articular extremities of the ribs, which were compressed from front to back and double headed, though they do not define its relation to the suture between the centrums. The notch between the heads and tubercle of the rib is very small, and the facets are almost equally deep.

The parapophysial head, for the side of the centrum extends $\frac{8}{10}$ inch beyond the diapophysial facet for the transverse process, in a small rib where the extreme measurement over the head of the bone is $1\frac{2}{10}$ inch; but in another specimen the diapophysial facet is vertical instead of oblique, and the parapophysial process much deeper, so that the vertical measurement as preserved is $1\frac{1}{2}$ inch, and the process articulating with centrum appears to be imperfect. The excavation beneath the diapophysial articulation is prolonged backwards as a groove, on the hinder side of the rib, which is otherwise vertically ovate in section, like a rib of *Ichthyosaurus*, which the posterior groove somewhat recalls. Its depth is about $\frac{7}{20}$ inch, and its width $\frac{5}{20}$ inch. The centrum in this series of vertebræ is relatively longer than in Eichwald's earliest vertebræ of the lower dorsal column, and I infer that it came from a more anterior part of the vertebral column, but there is nothing to suggest reference to the same species.

The associated flattened ilium is $2\frac{3}{10}$ inches wide as exposed at the inferior articular end. The vertical notch is exactly in the middle of its articular border, about $\frac{1}{4}$ inch wide, and somewhat higher. Its superior part is broken, but, as preserved, it is 3 inches high. Both anterior and posterior margins are concave, and it is $1\frac{4}{10}$ inch wide in the least transverse measurement in the middle of the bone. There is every reason to think that the transverse measurement of the superior crest would exceed the tranverse measurement at the articular end. The bone is flattened, concave from above downward, and the part which is lost presumably gave attachment to the sacral ribs.

The only vertebra which may probably be referred to *Rhopalodon* is figured by von Meyer, *loc. cit.*, plate 15, figs. 1–4, a lower dorsal with the centrum $\frac{3}{4}$ inch long.

The Humerus.

The only specimens of this bone known to me are those figured by Kutorga, von Meyer, and Trautschold. These fragments differ chiefly in size, and vary so little in character that all might be species of the same genus, with the exception of the small unnamed complete humerus figured by von Meyer.

Rhopalodon.—On the supposition that the proximal and distal ends of the humerus figured by von Meyer belonged to individuals of the same size, they indicate that the bone was 7 inches long and $3\frac{8}{10}$ inches wide at both the proximal and distal ends. The short shaft was $1\frac{1}{2}$ inch in diameter. The ent-epicondylar foramen is seen on both sides of the distal end of the bone, and passes vertically through it, and obliquely downward; but in the proximal end it is seen to pass transversely from the inner to the outer side. This appears to show that the two ends can only be brought into harmony by rotating through about a quarter of a circle, a condition the more remarkable since there is no appreciable twist in the shaft of the small humerus ('Palæontographica,' vol. 15, plate 18, figs. 4–8) already mentioned, in which neither

of the foramina are represented which characterize the larger specimens. This twist in the shaft, if it really existed, probably indicates that while the humerus was directed outward, its distal end was carried downward and backward.

If size is a character of any value, it is probable that the larger specimens figured by TRAUTSCHOLD and KUTORGA are referable to *Deuterosaurus* ; and the smaller fragments figured by VON MEYER may all belong to *Rhopalodon.*

The distal end of the humerus which I refer to *Deuterosaurus,* is the type of the genus *Brithopus,* figured by KUTORGA. TRAUTSCHOLD ('Nouv. Mém.' Moscou, t. 15, Plate 5, figs. 4–7) has inverted the fragment of the proximal part of the humerus of *Deuterosaurus,* so that the proximal end of the bone, notwithstanding its great transverse expansion, is really very imperfect, as I have determined by comparing the original specimen at Kazan with other types of Anomodonts in this country. The broken surface beneath the numbers 4 and 5 on the plate is the constricted shaft of the humerus, and not the fractured proximal end, as it appears to be in the figure.

The Pelvis of Deuterosaurus *and of* Rhopalodon.

The pelvis, in the Russian Permian Theriodonts, has hitherto been known only from the acetabular region, figured by EICHWALD and by VON MEYER. Those specimens indicate two widely different generic types, which may belong to distinct families of animals. I have examined these and other materials, and, by removal of the matrix, have obtained the complete ilia in association with the sacrum (Plate 62). As will hereafter appear, this fossil is distinct from those previously known, in so far as can be judged from the present preservation of the specimens. As EICHWALD'S type is exceptionally important in indicating a very young specimen, I briefly re-describe its characters. I regard it as the pelvis of *Deuterosaurus,* partly from the character of the femur, partly from its generic difference from the type named *Rhopalodon.*

Pelvis of Deuterosaurus.—This fossil represented, in the 'Lethæa Rossica,' plate 57, fig. 30, was referred by EICHWALD to *Eurosaurus* or *Rhopalodon.*

It has the head of the right femur in the acetabulum, by which the nomenclature of the bones is determined as ilium, pubis, and ischium. These bones are in loose union with each other, as though the fossil belonged to a young animal, and it may therefore be possible that it represents characters which are found subsequently modified as ossification became more perfect. The ilium is compressed from front to back, and what remains of it, is on the general pattern of the South African ilium referred provisionally to *Phocosaurus,* 'Phil. Trans.,' 1888, B, Plate 21, which may belong to an allied sub-ordinal group.

It is fractured at the transverse constriction above the acetabulum, where the antero-posterior measurement is $1\frac{1}{2}$ inch, while the width of the bone at the broad V-shaped suture with the other pelvic elements, does not exceed $3\frac{1}{2}$ inches. Only $2\frac{1}{4}$ inches of the vertical depth measured on the visceral surface is preserved.

What remains of the bone is nearly, though not quite, symmetrical; for the posterior lateral contour appears to be inclined at an angle of about 45 degrees, while the anterior margin is a rather steeper incline. The visceral surface is convex from side to side. In front, where the bone forms the upper half of the acetabulum, it has a singular trilobed appearance, owing to the development of a prominent superior articular tubercle above the middle of the acetabulum, which gives that part of the bone a thickness of $1\frac{1}{2}$ inch, and a width of $1\frac{1}{4}$ inch. On each side of it the ilium is compressed to a thickness of $\frac{1}{2}$ an inch, and is excavated by a notch, which passes under the supra-acetabular wedge into the acetabulum on both sides, but is much larger on the pubic side than on the side towards the ischium.

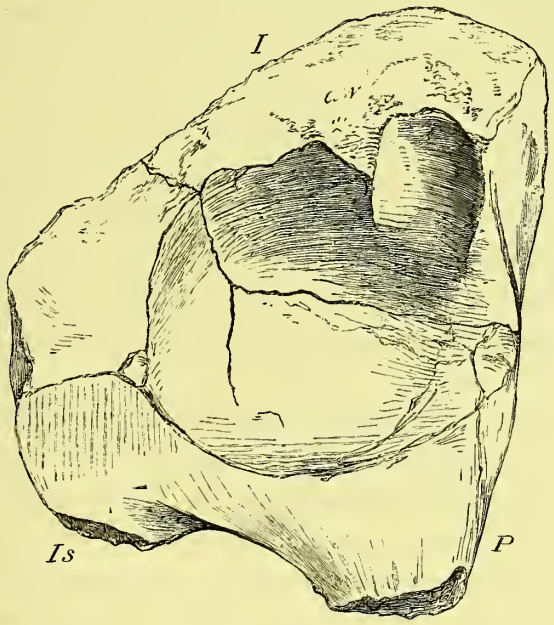
The ischium and pubis are both represented by sub-acetabular fragments. The ischium is the larger bone. It may be very slightly displaced backward. Its large oblong superior surface $2\frac{1}{2}$ inches long, and slightly convex in length, is fully $1\frac{1}{4}$ inch deep towards the hinder border of the acetabulum, but thinner towards the os pubis. It gives no indication of having been produced backward, while the lines of growth upon the bone converge distally, and at the distal fracture it is compressed. The union with the pubis was small and cartilaginous; the anterior margin is fractured, but evidently diverged backward from the pubis, though this divergence is similar in type to that seen in the formation of the comparatively large obturator foramen, which passes from within outward as it extends between these bones in another specimen, figured by VON MEYER.

The proximal end of the pubis as preserved is triangular in lateral contour, while the oblong flattened articular surface is 2 inches long and 1 inch thick. What remains of its anterior margin appears to be straight, but the obturator border is concave, and recedes from the ischium, indicating, I think, that the obturator foramen was extremely deep and Plesiosaurian, supposing it to have been completed distally. At the fracture of the pubis, $1\frac{1}{4}$ inch below the iliac surface, the section of the bone is a small oblique triangular area, with its axis passing diagonally inward and backward, measuring less than 1 inch long by less than half an inch thick. There appears to be some similarity in the form of pubis and ischium of this type, and the same bones in *Ichthyosaurus*, which is especially indicated in the straight anterior margin of the pubis, and the narrow proximal union between the pubis and ischium; and there would be a certain resemblance to the Ornithosaurian type, only in that group the antero-posterior constriction of the pelvis is never above the acetabulum, but either opposite to it or below it, and the pubis and ischium are more united.

These bones could only have enclosed a circular acetabulum as a consequence of completed ossification. The large size which appears to be indicated for the obturator foramen, would probably refer this fossil to a distinct genus from the specimen figured by VON MEYER, which has a nearly circular acetabulum with a very small obturator foramen, passing through the small pubis towards the large compressed ischium. VON MEYER, apparently, did not suspect that much was lost from the superior

margin of the ilium. The specimen represented in the 'Palæontographica,' vol. 15, p. 17, figs. 3 and 4, has the ilium remarkably constricted from side to side above the supra-acetabular process, so that the transverse measurement is 1 inch, while the measurement across the bones in the middle of the acetabulum is $3\frac{1}{4}$ inches. This, probably, caused him to compare the pelvis with that of *Nothosaurus*, in which there does not appear to be a superior crest to the ilium, and he refers to the foramen in the pubis as resembling that in *Dicynodon* and Lizards. There is a sufficient general resemblance between the specimens respectively figured by EICHWALD and VON MEYER, to show that they may be harmonized as different generic modifications of the same type.

Fig. 6.



Right acetabulum.

aw., supra-acetabular wedge; *i.*, ilium, defined by suture; *p.*, pubis, partly defined by suture; *is.*, ischium. Institute of Mines, St. Petersburg.

It sometimes happens that the sutures between the pubis and ischium are obliterated, and VON MEYER states that it is difficult to tell whether the pelvis is formed of two bones or three. There is no doubt that, as in Ornithosaurs, the anchylosis is much more complete between the pubis and ischium than between these bones and the ilium (fig. 6), but with the aid of a magnifying glass it may be traced along lines which are suggested by the separation of the bones in EICHWALD'S figure.

In the new specimen, lent me from St. Petersburg (Plate 62), both right and left iliac bones are present in fair preservation, but removal of the matrix has shown that they are in contact with two sacral ribs. The specimen is distorted, by pressure in folding the rocks, as in so many of the fossils from South Africa. On both sides the blade of the ilium is obliquely inclined to the vertebræ at the same angle, and, although the

contact with the sacral ribs is not very close, it is doubtful whether this obliquity is entirely attributable to pressure. The blade of the ilium is flat, and inclined upward, so that the bones appear to have approximated superiorly. The superior margin of this plate, which is massive in front and thin behind, is straight, and inclined so that its hinder margin rises to a level with the middle of the neural spine, and its anterior margin is on a level with the middle of the centrum. The blade of the bone expands in a fan shape having a distinct superior anterior process, and a longer superior posterior process. The contour of each limb is rounded at the extremity. The blade appears to have a length exceeding $3\frac{3}{4}$ inches, and a height above the supra-acetabular prominence of $2\frac{3}{4}$ inches. The anterior margin is moderately concave, and the posterior margin is a deep notch (fig. 4, Plate 62), which gives to the posterior process of the blade a depth of a little over an inch, and constricts the waist of the bone above the acetabulum, to a middle length of $1\frac{3}{4}$ inch. The consequence of this is that more than half of the antero-posterior extent of the blade of the bone, lies behind a line drawn vertically from the middle of the acetabular prominence at right angles to the superior border, and this constitutes a remarkable difference from all Anomodonts hitherto known. On the left side the anterior extremity of the blade of the ilium is curved outward almost imperceptibly as it extends forward, but there is no outward curve of the hinder extremity, which is not quite perfect. On the right side the outward direction is manifest at both ends of the blade, which is slightly concave in length.

The articular portion of the ilium is equally remarkable for its backward growth. Its transverse measurement is about 3 inches, and it is about $1\frac{1}{2}$ inch thick in the middle of the supra-acetabular process, which is one inch wide. This process is defined anteriorly by a slight notch, which separates it from the pubic border to the acetabulum. Posteriorly there is a very wide and deep notch, nearly an inch long, which has the effect of giving the posterior border of the ilium above it the aspect of a long, slender, rounded process. As the bone is placed, this process is nearly horizontal, over an inch long, convex in length, with the convexity prolonged backward by the ischium, a small fragment of which remains in contact, though the separation of the remainder of the ilium has followed the line of suture. I have seen no other specimen in which there is anything like the posterior notch now described, but the superior margin of the ilium inclines forward in *Pareiasaurus*; the axis of the pelvis is oblique in all Anomodonts, and all have the posterior border of the ilium more deeply concave than the anterior border. A similar backward development of the blade of the ilium is found in the South African Theriodont *Cynognathus*.

There are three generic types of pelvis from the Permian of Russia which may belong to four species.

The Femur of Deuterosaurus.

The examples of femoral bones indicate two or three generic types. First, there is

the large distal end of a femur, figured by EICHWALD, plate 59, fig 4, which has only a small portion of the shaft preserved, and is similar in character to the bone of like size drawn by VON MEYER, 'Palæontographica,' vol. 15, plate 19, figs. 1, 2, 3. The distal condylar surface of this specimen is only a little less than 5 inches wide. There is a considerable concavity between the condyles on the under side, below which a foramen is represented as opening. A larger foramen is similarly placed in *Pareiasaurus*. The superior surface also is concave, so that the distal end has a trochlear character. The greatest antero-posterior depth of the condyles is about $2\frac{1}{4}$ inches; and on the inner side the shaft is inflated, and on the outer side it is flattened. Only four inches of the shaft are preserved, and at the transverse fracture its section is regularly oblong. This I refer to *Deuterosaurus*.

A proximal fragment which might well belong to this type, is figured and described by TRAUTSCHOLD ('Nouv. Mém. Soc. Imp. Nat. Mosc.,' t. 15, plate 6). Something more than 10 inches of the shaft are preserved, with a head 5 inches wide, and the ovate distal end only little smaller than the fractured surface of VON MEYER'S bone. I have, therefore, thought of these specimens as presumably indicating a femur about 14 inches long or possibly rather more. The head of the bone shows a remarkable distinctive character in the external crest being compressed and defined by a concavity on the under side of the bone; but the crest is not directed appreciably downward. At the base of the concavity on the posterior or inferior aspect, at rather less than 4 inches from the proximal articulation, is the small trochanter, which is not marginal, as in Saurischian reptiles, or in some smaller Russian femora, but appears like a truncated tubercle on the under side of the shaft, inclined towards the hinder border. This position of the trochanter seems to me the most distinctive attribute of this Russian femur, which, however, less closely resembles the type of femur found in *Pareiasaurus* than do some smaller Russian femoral bones from these Permian deposits. The smaller femur figured by TRAUTSCHOLD (*loc. cit.*, plate 5, figs. 1, 2, and 3), and referred by him to *Platyops Stuckenbergi*, appears to be formed on the same plan, so that both might belong to the same genus or to allied genera.

The Skull of Rhopalodon (Plate 63).

A nearly complete skull is preserved in the Museum of the Institute of Mines at St. Petersburg, which corresponds closely in size with the fragment of a lower jaw on which FISCHER founded *Rhopalodon Wangenheimi*. The depth of the lower jaw is the same, the number of teeth in a given length of alveolar margin is the same, and the teeth are similarly club-shaped, though they appear to be relatively larger, so that the interspaces between them are small. I have therefore identified this skull with FISCHER DE WALDHEIM'S species.

In proportion and general aspect there is a general resemblance to the skull of the South African Dicynodont *Ptychognathus*. The nares, however, are not lateral, and

appear to have been terminal, as in *Deuterosaurus*, though the extremity of the snout is broken. The temporal vacuities, instead of meeting superiorly in a median parietal crest or ridge, appear to have been roofed over transversely; more in the manner of *Kistecephalus*. And there is some evidence, though by no means clear or conclusive, that the lateral post-orbital vacuities were partially closed by bone; so that the skull in this post-orbital region may have approximated to South African types like *Gorgonops* and *Pareiasaurus*; though the bones were neither sculptured as in the latter genus, nor smooth as in *Procolophon*.

The large circular orbits, *o*, defended with sclerotic plates, are vertical, and placed far backward in the skull. The parietal foramen, *pf.*, is almost as far backward as is possible, as in *Deuterosaurus*. The vertical occipital plate is only pierced by the large triangular foramen magnum, similar to that already drawn by von Meyer ('Palæontographica,' vol. 15, t. 21, fig. 3). The palate appears to have been closed, except for the palato-nares, which diverge backward from between the great canine teeth. The teeth can only be compared with those of the South African Theriodont Reptilia described by Sir R. Owen.

The upper surface of the skull, seen from above, is a long triangle (Plate 63, fig. 3). Its base is formed by the occipital plate, which is concave from side to side; but divided on its upper border into two lateral parts by a prominent rounded median tubercle, which is placed behind the parietal foramen. On the right side, in which the preservation appears to be most perfect, the measurement from the median line to the sutural border of the bone, laterally, is $1\frac{1}{4}$ inch, so that the transverse superior width is $2\frac{1}{2}$ inches; though the occipital plate widens as it extends downward. The median convexity on the roof of the skull (*f.*) is prolonged in front of the parietal foramen for about an inch in length, with a width of more than half an inch; but external to that convex area, which is defined on each side by a lateral depression, the roof bone of the head behind the orbits is concave, though the posterior border is slightly rounded. The superior border of the orbit is moderately convex from front to back. As the orbits converge forward, the transverse measurement at their hinder borders is about 3 inches, while at their anterior border it is about $1\frac{6}{10}$ inch. The width immediately in front of the orbits is $1\frac{4}{10}$ inch; and the width rapidly attenuates forward, though as the external film of bone, which was thin, has scaled from off the skull, it probably exceeded the $\frac{7}{10}$ths of an inch width, which is the transverse measurement at the anterior fracture, behind the nares. This long narrow nose is moderately convex in length, with two small parallel ridges in its median line, apparently upon the nasal bones, and a lateral ridge on each side, which separates the superior surface from the flat lateral almost vertical pre-orbital region; so that there is a general resemblance superiorly to the triangular form of the skull in *Deuterosaurus*.

The bones which form the roof of the skull are not all defined with similar distinctness. The parietal bone (*p.*) appears to be a triangular, or rather five-sided

ossification, less than one inch wide, in the centre of which the parietal foramen is placed.

In front of the parietal is the frontal bone, though the suture which separates them is not very conspicuous. The frontal bone is paired, and combines with the parietal to give attachment to the post-frontal (*pt.f.*), which arches over the post-orbital vacuity and the back of the orbit, resembling *Deuterosaurus* in its large development, though differently conditioned. There appears to be a supra-orbital ossification, but the defining suture is not clearly demonstrated. The frontal bones appear to terminate about $2\frac{3}{4}$ inches in front of the median occipital tubercle. Above the orbit they are margined laterally by the pre-frontal bones (*pr.f.*); and for 2 inches or more the front of the snout is roofed by the pair of nasal bones.

The lateral aspect of the skull is flattened and somewhat oblique, about 3 inches in depth; but the anterior extremity is not preserved.

The rami of the lower jaw meet together in front, and since the canine tooth extends in front of the lower jaw, it is improbable that any material part of the snout is lost. The extreme length of the skull, as preserved, is $8\frac{1}{2}$ inches; and its depth below the orbit is less than along the alveolar margin; but the lower jaw appears to fit within the malar region beneath the orbit, being so contained on the left side, though the skull is slightly distorted.

The pre-maxillary bones are apparently not preserved, or if preserved their defining sutures are not shown. They were presumably small, and placed in the median line below the nares. Hence no incisor teeth are seen.

The lateral alveolar border is apparently straight, and extends for a length of about $2\frac{3}{4}$ inches, formed by the maxillary bone, which extends vertically upward to the nasal bone, and terminates posteriorly by an almost vertical suture inclined a little backward and downward, which marks its junction with the very large lachrymal bone.

The lachrymal bone appears to have been vertically oblong, about $1\frac{7}{10}$ inch deep and $\frac{3}{4}$ inch from front to back in the middle.

The skull appears to extend fully $4\frac{1}{2}$ inches to 5 inches in front of the orbit, beneath which is the malar bone. That bone meets both the maxillary and the lachrymal, and is about $\frac{7}{10}$ inch deep.

The malar bone appears to be overlapped behind the orbit by the quadrato-jugal, which extends backward to the quadrate bone, and descends in front of the articular condyle of the lower jaw, which is situate $6\frac{1}{2}$ inches behind the anterior symphysis of the mandible, measured from its posterior border, and below the hinder margin of the orbit.

The orbit is slightly distorted by pressure; on the left side it is vertically ovate and on the right side transversely ovate. It is remarkable for showing the circle of sclerotic bones. The sclerotic plates are well preserved on the right side only. They were thin oblong bones, in contact at their edges by fairly straight sutures.

Their inner borders define a circle which was less than an inch in diameter. The individual plates appear, where largest, to be $\frac{4}{10}$ inch deep, and $\frac{1}{4}$ inch wide, though they are not all of quite the same size. The external half of each plate is convex from above downward, and appears to have been in contact with the frontal bones. The internal half is concave in depth. The number of bones is about ten in half the orbital circle, so that probably not more than twenty-two originally composed the sclerotic circle. There is some evidence on the right side of the head, of the post-orbital area having been entirely, or almost entirely, covered with bone (Plate 63, figs. 1 and 3). There is an impression behind the orbit, but whether produced by a skull structure is not clear; and behind this there is another indefinable impression descending to the quadrato-jugal region. It is situate as though it comprised the supra-temporal and squamosal bones, but there is no evidence which can be regarded as conclusive that the former bone was present in that position.

The teeth in the maxillary bone admit of being counted both in the jaw and in the external cast of the bone. In the jaw, on the left side, the number of teeth in the alveolar border of the maxillary bone is seven, in a length of rather less than 2 inches. The diastema of half-an-inch between the first molar and the canine is occupied by the root of a successional tooth, which was somewhat larger than the molar teeth, and much longer in its root; and from its position has the aspect of being a successional canine, the root of which has not been entirely absorbed. There is an impression on the region of the diastema, as though a tooth may have rested upon it. On the right side, the impression of the canine is distinct, but there appear to be two teeth behind it, one of which is in the position of the tooth which I have alluded to, as in the position of a successional canine. There is a diastema, which may indicate one tooth between the second of these impressions and the next tooth preserved, and then follow indications of five more teeth, so that there appear to be eight maxillary teeth in addition to the canine. On the right side the whole of the teeth are broken, being fractured obliquely; but these fractures show that the crowns were oblique, the axis of each extending inward and backward. The impression of the last tooth shows indications of serration on its anterior border. The teeth are large in their roots, separated from each other; the antero-posterior measurement over the four anterior is $1\frac{1}{10}$ inch, and over the seven it is $1\frac{9}{10}$ inch. On the right side there is a complete crown. It is apparently the third or fourth molar, and projects from the alveolar margin about $\frac{11}{20}$ of an inch. At the base it is barely $\frac{5}{20}$ inch wide. It descends straight, its external surface is convex, especially towards the anterior side. On the posterior part there is a delicate fluting. The straight posterior edge is finely serrated, by transverse serrations in the Megalosauroid pattern (Plate 63, fig. 2); and the anterior margin is also serrated towards the summit, but there is no serration towards the base of the crown. The inner side of the crown of the tooth is much flatter. The external surface is convex from above downward, and the summit of the tooth inclines a little inward. There is an anterior

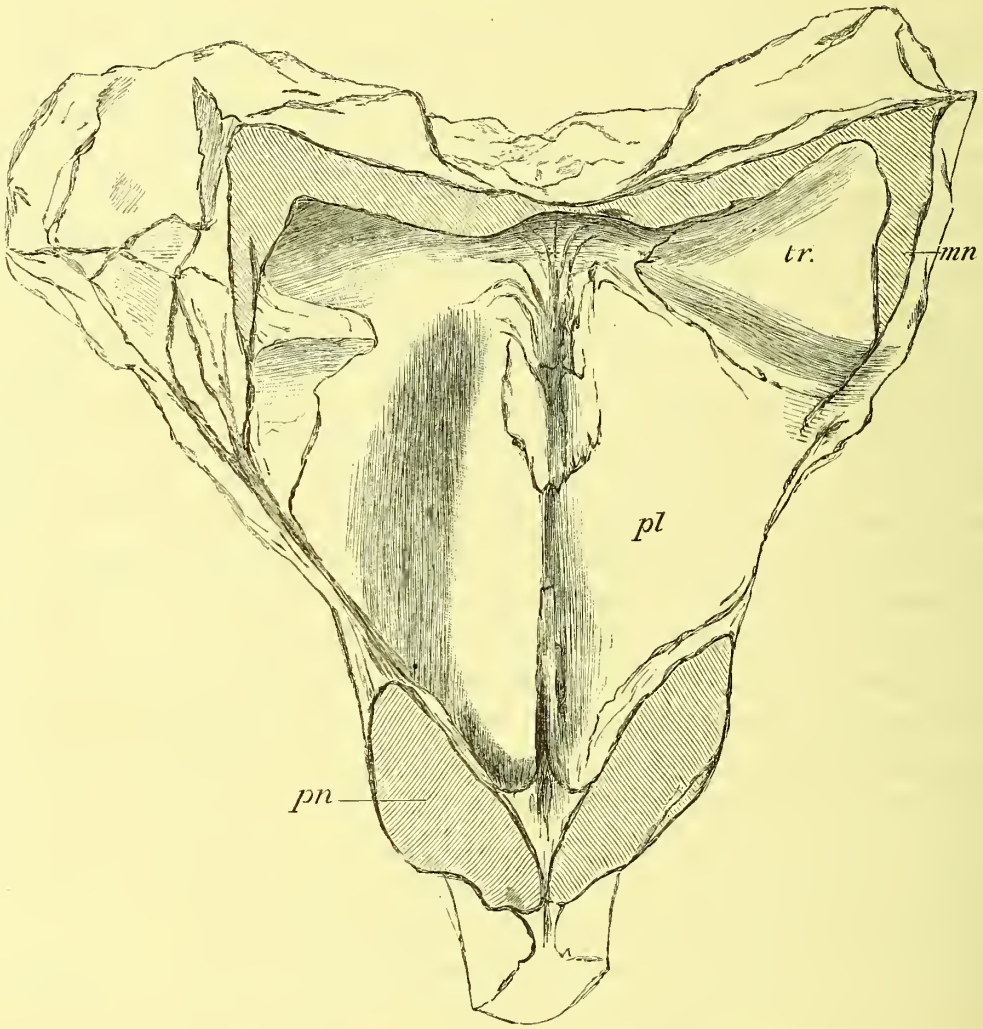
fluting behind the serrations, shown in an impression of the next tooth but two, which may be reckoned the seventh molar.

The canine tooth is only preserved upon the left side, though there is an impression of a portion of its root upon the right side. The greater part of the root on the left side is broken away, and the extremity of the crown is not at present exposed, but the length of tooth and root probably exceeded 3 inches. It was strong, directed downward, and apparently a little outward, following the inclination of the facial region of the head, which here curves outward, so that the tooth passes external to the mandible (*mn.*). The base of the crown, as preserved, is $\frac{7}{10}$ inch from front to back and appears to be fully $\frac{4}{10}$ inch or more in thickness, and flatter on the external surface than on the internal surface. The crown may have been $1\frac{1}{2}$ inch long; the part exposed measures $1\frac{1}{4}$ inch. The enamel is only shown on a part of the anterior extremity, which is convex, except that the convexity passes into a blunt ridge, which becomes a series of serrations towards the end of the anterior border. The posterior border is not exposed. The enamel shows not only fine longitudinal ribs, which are faintly elevated, but a more conspicuous transverse banding, which in its smooth undulation gives a ripple-like ornament. There is the faintest indication of the same structure of the surface of the enamel in the molar tooth, where the transverse bars seem to extend from the posterior serrations of the tooth, but I do not detect them on the anterior convexity of that crown so strongly as on its posterior part. There is no evidence of any teeth anterior to the canines, though the state of preservation of the specimen does not enable me to form any opinion as to whether such teeth were developed. The most anterior molar is on the inner side of the canine, and the lower jaw, as preserved, does not extend in advance of the canine, though it does appear as though it might have terminated, when perfect, half an inch further forward than now, and such a position would have allowed ample space for incisor teeth. There is possibly the impression of one such tooth, distinguished by being of small size, directed obliquely forward.

The palate is not exposed on the palatal surface of the bones. The anterior nares show no sign of median division, as exposed above the posterior symphysis of the lower jaw. They form a small vacuity, concave above, with a median ridge descending from above and concave below, with a broad open V form. The width of this vacuity is about twice its depth. The palato-nares open between the canines; they are divided by the vomerine bone (compare Eichwald, 'Lethæa Rossica,' plate 58, fig. 7). They are vacuities $1\frac{1}{4}$ inch long, as exposed on the superior internal surface of the palate, narrowing anteriorly and posteriorly, with a width in the middle of about half an inch, bounded externally by the maxillary bones. They necessarily diverge outward. The palate forms a triangular area behind them. Its surface is divided by a median ascending ridge into two triangles, which are concave from side to side. The hinder part of the palate is manifestly formed by the transverse bones, which extend transversely, and descending from strong buttresses abut against the coronoid region

of the lower jaw; but over the whole of this completely closed palate only one bone appears to extend on each side behind the palato-nares, and that bone is the palatine in front, but may be regarded as the transverse behind.

Fig. 7.

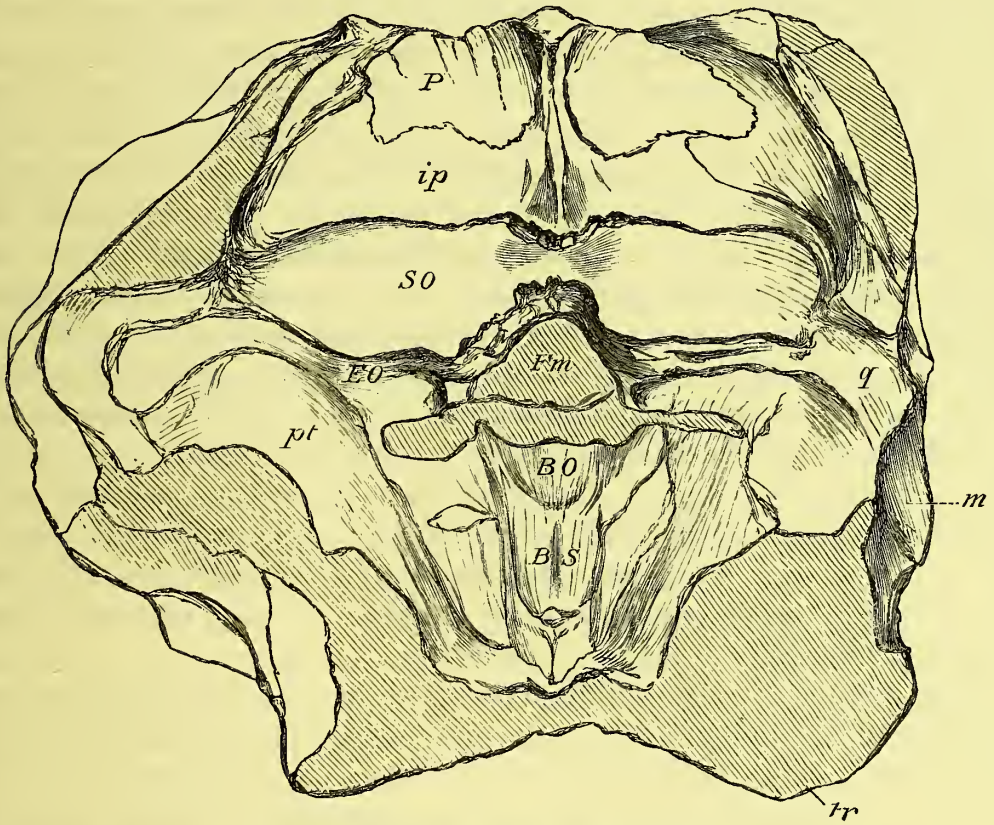


Internal or superior aspect of the bones of the palate.
pn., palato-nares; *pl.*, palative bones; *tr.*, transverse bone; *mn.*, mandible; the jaws are not shown.

The back of the skull presents an aspect intermediate between that of *Ptychognathus* and *Crocodilus*. The skull has a transversely broad occipital plate above the foramen magnum, while its base below that foramen contracts from side to side as it descends, and extends forward to the pterygoid region, though unfortunately the bone-tissue is lost from this area below the foramen magnum, and its anatomy is only known from the internal sutures displayed by the impressions of the missing bones. It is convenient to commence the description from the inferior surface. It has been seen that the lateral termination of the transverse bones has a transverse width of about

$3\frac{4}{10}$ inches (compare *Rhopalodon Murchisoni* (FISCHER), 'Lethæa Rossica,' plate 58, fig. 8), and that, although slightly oblique, the wedge-shaped external thickening is much more nearly vertical than in the Crocodile, and presents a flattened posterior surface, the inferior margin of which is concave, and which meets the base of the brain-case in a median transverse suture. From this arises the basal region of the cranium. Its transverse width just above the pterygoid bones is $1\frac{1}{10}$ inch. Owing to the state of preservation, it is difficult to be certain of the limits and identification of all the bones. In the median line this basi-cranial region is $1\frac{6}{10}$ inch deep to the

Fig. 8.



Posterior aspect of skull of *Rhopalodon*.

P., parietal bone; *ip.*, inter-parietal; *SO.*, supra-occipital; *Fm.*, foramen magnum; *EO.*, ex-occipital; *q.*, quadrate; *pt.*, pterygoid; *tr.*, transverse; *BO.*, basi-occipital; *BS.*, basi-sphenoid; *m.*, mandible.

occipital condyle, and the transverse width over the wedge-shaped area, from which the film of bone which covered it is partly lost, is $2\frac{2}{10}$ inches superiorly. This longitudinal mass appears to be divided transversely by two sutures, which lead me to suppose that it comprises the basi-occipital, *BO*, basi-sphenoid *BS*, and pre-sphenoid elements of the skull. The basi-occipital portion, if rightly identified, is very short and badly preserved, and shows upon the left side indications of a transversely ovate condyle, which was separated from the condyle of the opposite side by a small concavity.

That condyle is not preserved, nor have I the advantage of studying the external covering of rock, which has been broken away from the occipital plate. The width of this condylar surface as exposed is less than half an inch, and I estimate that it showed when complete and undistorted a transverse condylar width which but little exceeded one inch. The condyle figured by von Meyer, 'Palæont.,' bd. 15, plate 21, fig. 3, appears to have been wider, and may belong to the genus *Dinosaurus*. The antero-posterior extent of the basi-occipital in this skull of *Rhopalodon* did not, I believe, exceed $\frac{3}{10}$ inch. The basi-sphenoid was much longer, measuring nearly an inch in length. In the middle, close together, are the casts of two blood vessels of small size, in the position which is usually occupied by the internal carotid arteries. The bone in front of the basi-sphenoid which appears to reach to the pterygoid is imperfectly exposed. In the crocodile a plate of the quadrate bone laps along the side of the brain case, with a contour scarcely distinguishable from this specimen. But I see no reason for identifying the lateral flanking plate of this fossil with the quadrate. It lies below the ex-occipital and squamosal. The ex-occipitals extend transversely outwards, and abut against lateral bones which continue the arch of the side of the skull upward, forming the inner wall of the temporal vacuity; therefore, presumably the squamosal bone. The transverse measurement of the ex-occipital is $\frac{7}{10}$ inch. It is directed outward horizontally, appears to be compressed from front to back with its inferior border concave; and its superior border is concave so as to make the depth of the bone externally about half an inch. There is an appearance as though a vertebra had been in contact with the basi-occipital, and had left but a small foramen exposed; though from the similarity of the matrix to the texture of the bone when broken, it is difficult to be sure whether the occipital condyle was not formed of the basi-occipital and ex-occipital bones, and whether the surface below is not the inferior tuberosity of the basi-occipital bone.

The supra-occipital is a large ossification, which extends horizontally across the back of the skull for about 3 inches. Its superior border is defined by a horizontal transverse suture, and the bone is about $\frac{8}{10}$ inch deep. At the sides of the foramen magnum it is compressed, so as to margin it by sharp edges, which approximate in aspect to the condition of posterior zygapophyses. The bone is concave from side to side. The superior suture which limits it is somewhat sinuous. Above it is the inter-parietal plate, $1\frac{1}{10}$ inch deep in the median line, which is traversed by a vertical median ridge. It overlaps the supra-occipital by squamous union, and as it extends outward, curves backward, and extends above the supra-occipital, on to the junction of the quadrato-jugal with the quadrate. There is some indication that this bone consists of two portions, an internal part which lies behind the parietal bone, which would correspond in position to the inter-parietal, though the suture defining it, if it ever existed, is only to be doubtfully traced, and an external claw-shaped portion behind the post-frontal which is in the position of the squamosal bone. It thus

appears that the closure of the back of the skull may be attributed to the union of the inter-parietal with the supra-occipital and squamosal.

The squamosal bone prolongs the curvature of the post-frontal bone downward, till its extremity recurves forward above the quadrato-jugal. Therefore there is some ground for doubt whether the lateral post-orbital vacuities were covered with bone, and the impressions which rest upon them are probably marks of vegetable substances.

The two rami of the lower jaw converge in front, but posteriorly the width over the condyles exceeds four inches. Each ramus is slightly sigmoid, at least on its inner surface, curving inward at the posterior extremity, and a little outward in front. The external surface of the lower jaw is vertical, about $1\frac{3}{20}$ inch deep, though somewhat less, apparently, in the middle length, owing to a slight concavity of the inferior margin; and deeper behind, where the jaw depth exceeds $1\frac{7}{10}$ inch, towards the orbital region. The superior alveolar margin shows nine teeth, with an interspace which might have contained another, without counting what may be a minute tooth further back in the jaw. On the external cast eight impressions are counted, to which must be added one from the evidence of the other side of the jaw. There is another tooth with its root deeply sunk in the anterior extremity of the lower jaw, so that it might be regarded as an incisor, rising before the extremity of the beak, in the position of an incisor tooth at the extremity of the lower jaw. It ascends so as to cross in front of the upper jaw canine, but was smaller than the canine, and is very similar in character and position to the impression which may be traced in Fischer's figure of the extremity of the jaw of *Rhopalodon Wangenheimii*. The jaw is compressed from side to side, composite, consisting mainly of the dentary bone, showing the splenial bone internal to it, and the angular bone external.

The inferior angle of the jaw appears to be a little inflected posteriorly, in front of the articulation, but the preservation is too imperfect to determine whether there was any approximation to the condition of the articular end of the bone found in South African Theriodonts. There is no indication of the condyle of the quadrate bone. The pterygoid bone reaches the inner side of the quadrate, but in this fossil the quadrate would appear to be behind the pterygoid, unless the bone (*pt.*) which flanks the basi-cranial axis laterally is pterygoid. Though the rami are in contact in front, and there appears to be a symphysis, the extremely thin alveolar margin is broken away from the extremity of the jaw. The external surface of the dentary bone is roughened with irregular longitudinal wavy striations and punctured roughnesses.

Scapular Arch of Rhopalodon.

The scapular arch in the Russian Deuterosauria has been imperfectly known. Von Meyer, in 1866, figured ('Palæontographica,' vol. 15, plate 17, fig. 1) a part of the shoulder girdle which shows the articular cavity for the humerus; and the blade of the scapula is well preserved and shown in plate 18, figs. 1 and 2. The extremity of

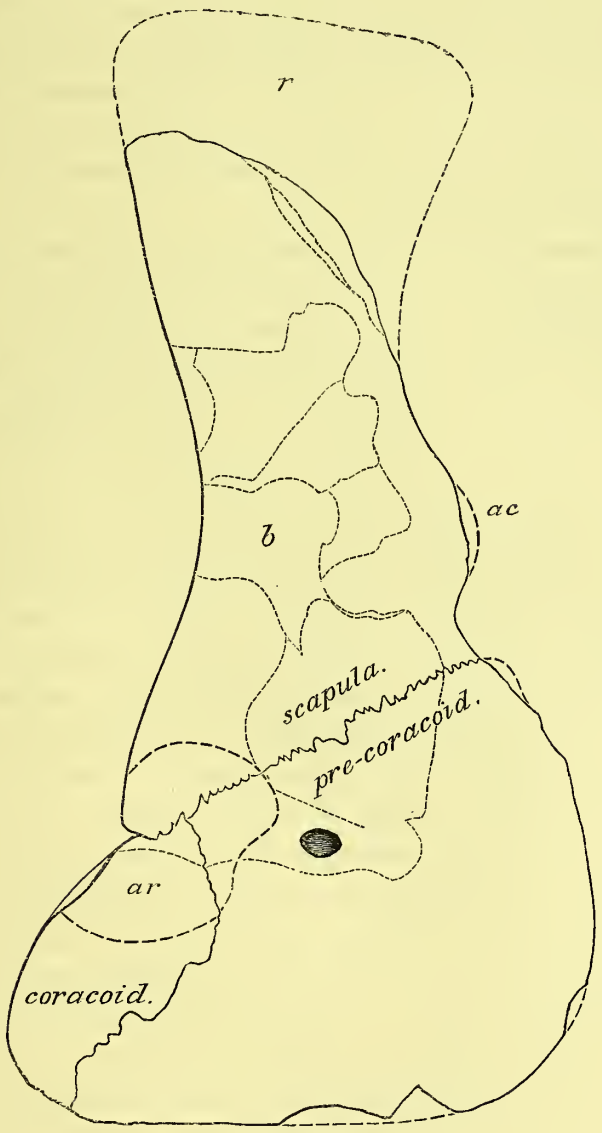
the blade is absent, but is figured in plate 20, figs. 1 and 2, which may be referred to an allied species. These remains are sufficient to define the suture between the scapula and coracoid, which is seen to pass through the humeral articulation towards a foramen on the internal aspect of the bone, where it forms a considerable lunate excavation, partly in the scapula, partly in what I regard as the precoracoid bone, and entirely separate from the coracoid bone. The contours of the precoracoid and coracoid are not suggested by these specimens. A fossil figured by EICHWALD, 1860, in his 'Lethæa Rossica,' plate 57, fig. 27, as an undetermined bone, is certainly the shoulder girdle, nearly perfect, and completes a knowledge of the scapular arch of an animal similar in size and organization to those indicated by Major WANGENHEIM VON QUALEN'S fossils, figured by VON MEYER. This is probably the specimen now described by the kindness of the authorities of the Museum of the Institute of Mines of St. Petersburg, which may have hitherto escaped recognition from being labelled "Beckenknochen" and "untere rechte Seite, os pubis." In general aspect the impression of the bones is remarkably like a pelvis in form, especially such a type as Professor COPE figures under the name *Eryops megacephalus*, but there is no evidence of median symphysis, and the foramen through the bone is not conditioned as in the os pubis, but exactly as in the specimen of the shoulder girdle attributed by VON MEYER to *Eurosaurus* (*loc. cit.*, plate 17, figs. 1 and 2). On the whole, this Russian shoulder girdle is more nearly paralleled by that of *Pareiasaurus* than by any Dicynodont remains known to me.

The fossil consists of an impression of the shoulder girdle, which is imperfect towards the free end of the scapula, from which a length of one to two inches is lost. This, however, is partly the effect of a fracture and displacement after fossilization, by which the upper part of the blade has been forced downward over its middle part, so as to give the visceral side of the bone an amount of curvature which is not natural to it, and exceeds that figured by VON MEYER (*loc. cit.*, plate 18, fig. 2). There is an obvious truncation of the free end of the scapular impression by fracture. And when the longitudinal muscular lines on the superior border of the impression of the bone are compared with those upon the proximal end of the blade of VON MEYER'S scapula (*loc. cit.*, plate 20, figs. 1 and 2) the amount of surface lost may be approximately estimated. This triangular impression of the shoulder girdle as preserved is 10 inches long and $6\frac{1}{2}$ inches deep at the anterior end. The larger part of the bone which gave the impression is lost, but there remains a considerable fragment, 6 inches long, chiefly formed by the scapula, but showing the suture with the precoracoid, the precoracoid foramen, and an indication of the humeral articulation, which is imperfect.

As preserved, the total length of the scapula indicated by bone, or its impression, is $7\frac{1}{4}$ inches, to which I have inferred that as much as 2 inches may possibly be added. The specimen would then equal in length the outline of a scapula figured by VON MEYER (*loc. cit.*, plate 18, fig. 1) which appears to be $9\frac{1}{4}$ inches, and the length of the coracoid is $2\frac{3}{4}$ inches, as indicated by the impression. The transverse width of

the scapula, measured on the under side in the line of suture with the coracoid and precoracoid, is $4\frac{1}{4}$ inches, and this suture passes nearly vertically down the bony mass. From the suture the scapula becomes narrower as it extends backward. No evidence

Fig. 9.



$\frac{1}{2}$ nat. size.

Right shoulder girdle based on an impression of the visceral surface.
ar., outline of humeral articulation restored from VON MEYER'S specimen. *b.*, bone. The fine dotted outline indicates fractures. *ac.*, acromion. *r.*, restoration.

is preserved of a mesoscapular thickening of the bone like that seen in *Pareiasaurus*, but there is some evidence of a mesoscapular margin, which is defined by a notch half an inch long, which occurs just behind the suture with the precoracoid. The

least width, indicated at 3 inches above the suture with the coracoid, is $2\frac{1}{4}$ inches. The free extremity of the bone does not appear to have exceeded a width of $3\frac{1}{2}$ inches, but, as preserved, the width is less. The inferior margin both of scapula and coracoid is concave, with a special concavity indicated at the humeral articulation. The bone is flattened in its blade, gently convex from above downward, as well as in length, with the inferior margin increasing in depth as it approaches the humeral articulation, until from being under $\frac{5}{8}$ inch in greatest thickness at the posterior fracture it becomes $1\frac{3}{4}$ inch thick above the humeral articulation. The superior portion of the bone which comprises the greater part of its surface, is flat and becomes more and more compressed, so that the bone is thinner the nearer it approaches to the superior edge, where it is about $\frac{1}{8}$ of an inch thick.

One of the most interesting features of this scapula is seen upon the visceral surface of the free end, at its upper extremity, where the bone develops a longitudinal ridge which, though imperfectly preserved, I suppose to be homologous with a corresponding ridge much more developed in the South African fossil *Cynognathus*. This ridge is much more obvious than the striations in VON MEYER'S figure, plate 20, fig. 1, indicate in that specimen, but very much less developed than in the South African *Cynognathus*; and is chiefly of interest as showing the first incipient stages of development of the superior margin of the blade of the scapula in the Theriodonts of both Russia and Africa, which parallels the anterior border of the scapula in mammals.

The precoracoid is a comparatively large bone, and the coracoid is a small ossification, which can, I think, be traced by the line of suture upon the internal mould; from which it appears that the precoracoid is sub-quadrate in form, with the anterior margin vertical, and the superior or clavicular margin moderately convex, with the angle between them rounded. The superior margin is more than 4 inches long, and the vertical or inter-clavicular margin is 5 inches long. Only a small part of the bone adjacent to the scapula is preserved, and the line of suture is marked by the elevated ridge, which is also shown as obliquely crossing the extremity of VON MEYER'S specimen (figured *loc. cit.*, plate 18, fig. 1). The bone is compressed in two directions, first, superiorly towards the clavicular margin; and, secondly, anteriorly towards the inter-clavicular margin, rapidly decreasing in thickness from the humeral articulation, to the superior border of which it appears to contribute. The precoracoid foramen upon the external surface, above the humeral articulation, is small and somewhat ovate, about $\frac{1}{4}$ inch in diameter, conditioned exactly as in the example figured by VON MEYER. It is $2\frac{3}{4}$ inches behind the inter-clavicular, or anterior margin, and over 3 inches below the clavicular, or superior margin. It passes longitudinally backward through the bone to its inner surface, where it is prolonged as a large lunate excavation, which makes the inferior border concave, and is not bordered at all superiorly, though it is fully $\frac{1}{2}$ an inch deep, and may be measured at $1\frac{1}{2}$ to 2 inches in length. The excavation lies nearly equally in the precoracoid bone and the scapula. Owing to this excavation the foramen is nearly parallel to the external surface of the

bone. The inferior or visceral surface of the precoracoid combines with the coracoid to form a large, vertically oblong concavity, which covers its whole area like a shallow ladle. There is no reason for supposing that this appearance is due to accidental compression, and the bone appears to have terminated all round its margin in a very thin edge.

The coracoid appears to have measured not more than $2\frac{3}{4}$ inches along its inferior border, $2\frac{1}{4}$ inches high at the articulation, and not more than $2\frac{1}{2}$ inches deep in any part of its measurement, so that it was a small sub-quadrate ossification, with the inferior and anterior borders convex. In its small size it approximates to the coracoid of the South African Theriodonts, which I obtained at Lady Frere (*Cynognathus*), in which, however, the precoracoid bone gives no evidence, as preserved, of the enormous expansion seen in this fossil. It is a remarkable circumstance that the outline of the left scapula, figured by VON MEYER, corresponds in size and form, and to a great extent in indication of the bone, and its impression, with this fragment of scapula here described, so that it might almost be supposed that VON MEYER'S figure, plate 18, fig. 1, was based upon a reversed drawing of the same bones when they were in a more perfect condition. All these specimens I refer to *Rhopalodon*.

The only large specimen of scapula from South Africa previously figured is that referred to *Dicynodon leoniceps* by Sir R. OWEN ('Cat. South Af. Rep.,' plate 70, fig. 1). That figure shows no more than a general resemblance to this Russian type, though the correspondence strongly suggests that the large specimen which EICHWALD figures (*loc. cit.*, plate 57, fig. 26) as an undetermined bone of triangular form, is the blade of a scapula of not entirely dissimilar character; but since what I take to be the free posterior margin is $10\frac{1}{2}$ inches wide, and what remains of the blade is a foot long, it would appear to indicate a fossil which might have been nearly twice the dimensions of the *Dicynodon leoniceps*, and it may be regarded as pertaining to the largest of the Russian Theriodonts, and identified as probably the right scapula of *Deuterosaurus*. The figure given by OWEN (*loc. cit.*, plate 69) of a portion of a Dicynodont scapular arch, shows that the precoracoid bone is perforated ('Phil. Trans.,' vol. 179, B, p. 492) much as in the Russian fossil, except that the perforation adjoins the scapular margin, and the result is, it pierces the scapula as an oblong notch, instead of forming the lunate excavation seen on the under side in all the Russian specimens. In the South African fossils referred to *Dicynodon*, the precoracoid is smaller, the superior margin of the scapula less expanded, and the coracoid larger and more produced downward, and it is only in *Pareiasaurus* that the precoracoid is equally large, or that the shoulder-girdle, as a whole, can be compared with this fossil. Seeing that the antero-posterior measurement of the scapular arch in that genus is 27 inches, and the length of the skeleton, including the tail, about 10 feet, it might be inferred, if the proportions were at all similar, that the total length of the *Rhopalodon* was about 4 feet 6 inches.

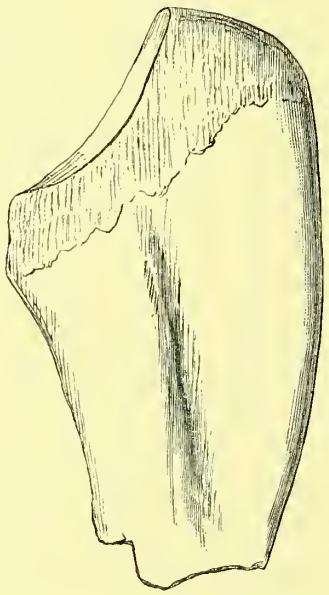
No trace of the tail has been discovered in Russian genera. There is some evidence to show that the tail was small, or, at least, that the first caudal vertebra had a smaller articular face than the last of the dorsal series; so that the length of the animal may not have greatly exceeded three feet.

The scapular arch appears to be intermediate in *Rhopalodon* between the *Pareiasaurus* and the South African Theriodonts. Of *Deuterosaurus* only the blade of the scapula is identified, and this appears to resemble the blade of the scapula of *Dicynodon leoniceps*.

Ulna of Rhopalodon.

There is preserved in the Institute of Mines at St. Petersburg, a proximal fragment of an ulna obtained from the Santangulowsk Mine, in the Province of Ufa. It is only three inches long and is compressed from side to side, as though the radius were a more important element in the humeral articulation. The transverse width below the articular surface is nearly $1\frac{7}{10}$ inch, but the thickness of the bone in the opposite direction did not exceed $\frac{17}{20}$ of an inch. The articular surface is somewhat oblong,

Fig. 10.



Proximal end of ulna. Nat. size.

oblique, concave from above downward, $1\frac{3}{10}$ inch long, truncated at the proximal end, with a slight concavity on the anterior margin towards the radius, which appears to be homologous with that in *Pareiasaurus*, though very much less developed. This concavity seems to me to determine the bone as the left ulna. The posterior surface at the proximal end is flattened, and the anterior surface is more convex, and converges somewhat backward to the rounded posterior margin. There is no prolongation of the bone proximally beyond the articular surface, so that the ulna is no more

developed proximally than in a Lizard; the only difference being in the proximal truncation, which is about $\frac{7}{10}$ inch wide. The posterior contour of the bone is convex, and the anterior contour concave, so that the two borders approximate, and give the bone a curved appearance. At the distal fracture the bone is $\frac{9}{10}$ inch from front to back. Though more developed than in *Eurycarpus*, 'Phil. Trans.,' 1889, B, Plate 18, the proximal end of the bone is much less developed than in *Pareiasaurus*. I have no certain knowledge at present of the ulna in any of the South African Theriodonts.

The bone may have been about six inches long.

The large bone figured by Eichwald (*loc. cit.*, vol. 57, fig. 28) I regard as the radius of *Deuterosaurus*; but of the ulna, or other bones of the extremities in that genus I have seen no evidence.

Ilium of Rhopalodon.

A specimen of ilium belonging to the St. Petersburg Museum has nearly the whole of the proximal half of the bone preserved, but only shows the internal mould of the

Fig 11.

Contour of ilium. Nat. size.

i., expansion of superior crest; *f.*, fracture. The inferior angle is inferred to mark the division between the pubis and ischium.

acetabular half, terminating inferiorly in the broad V-shaped line of suture, with the lower pelvic bones. If the lateral border, which is least concave is taken as anterior, and the straight superior margin, which is three inches long, is inferred to be parallel

to the vertebral axis, then the vertebral direction of the ilium is inclined a little backward.

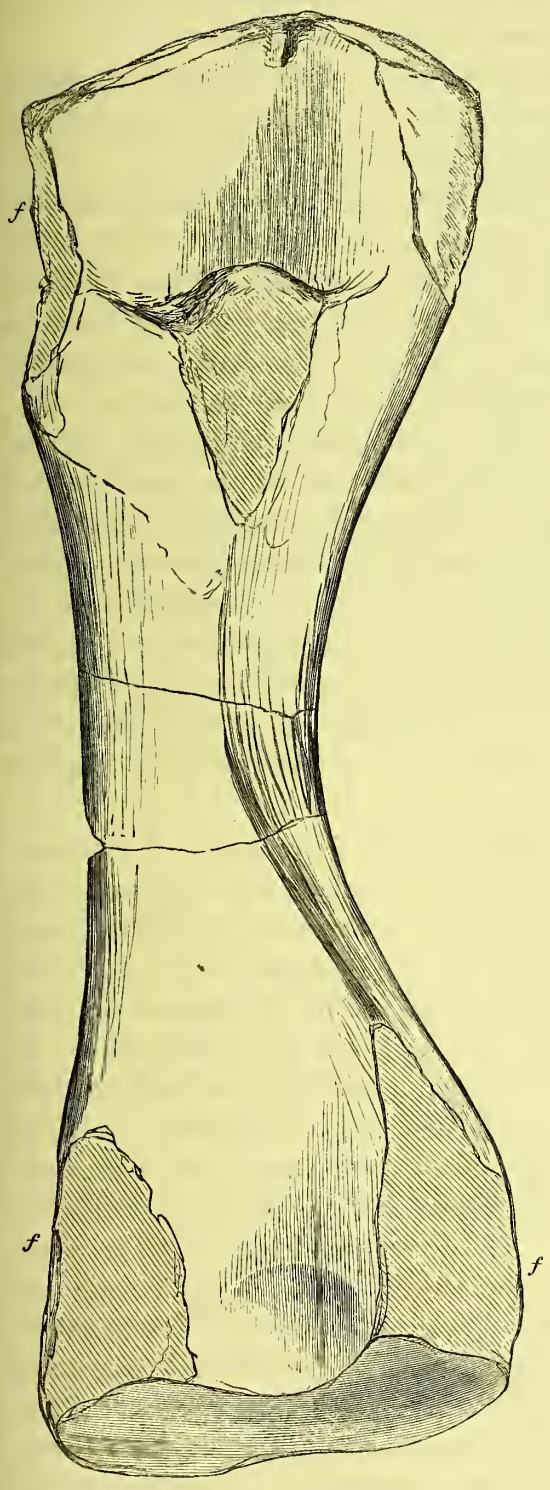
The superior blade is flat and smooth externally, and terminates in front in a somewhat compressed margin which is moderately concave in depth, where it measures $3\frac{7}{10}$ inches. The depth from the posterior angle to the corresponding point of the ischial suture does not appear to have exceeded 2 inches. The posterior border is not perfectly preserved, and may have been a little wider than the specimen indicates in its present position. As preserved the transverse measurement across the waist of the bone is $1\frac{8}{10}$ inch, and the transverse measurement at the ischio-pubic suture is $2\frac{8}{10}$ inches. The posterior surface is evenly convex from side to side, and slightly convex from above downward in its lower half, but in the upper half it appears to be more concave in the thickened area which gave attachment to the sacral ribs. The remarkable point about this bone is that its vertical depth appears to greatly exceed the length of the crest; while the bone agrees with other specimens in having the posterior border deeply concave, but appears to differ from other specimens in having the anterior margin sharply pointed. This will be evident by comparing the figure given below with that of the type previously described. It is a remarkable circumstance that the diversity in form and proportion and character of the known remains of the pelvis and femur is greater than that in other parts of the skeleton. And these characters probably differentiate more species than can be established on modifications of the skull. Provisionally these types may all be referred to *Rhopalodon*.

The Femur of Rhopalodon *and of* Dinosaurus.

A second type of femur, preserved in the Institute of Mines at St. Petersburg, is only known from the proximal end, and I regard it as indicating a bone about 6 inches long. The fragment preserved is 3 inches long, $2\frac{1}{2}$ inches wide below the proximal articulation, and about 1 inch wide at the distal fracture, where it is $\frac{6}{10}$th inch thick. It is figured at plate 61, figs. 3–6.

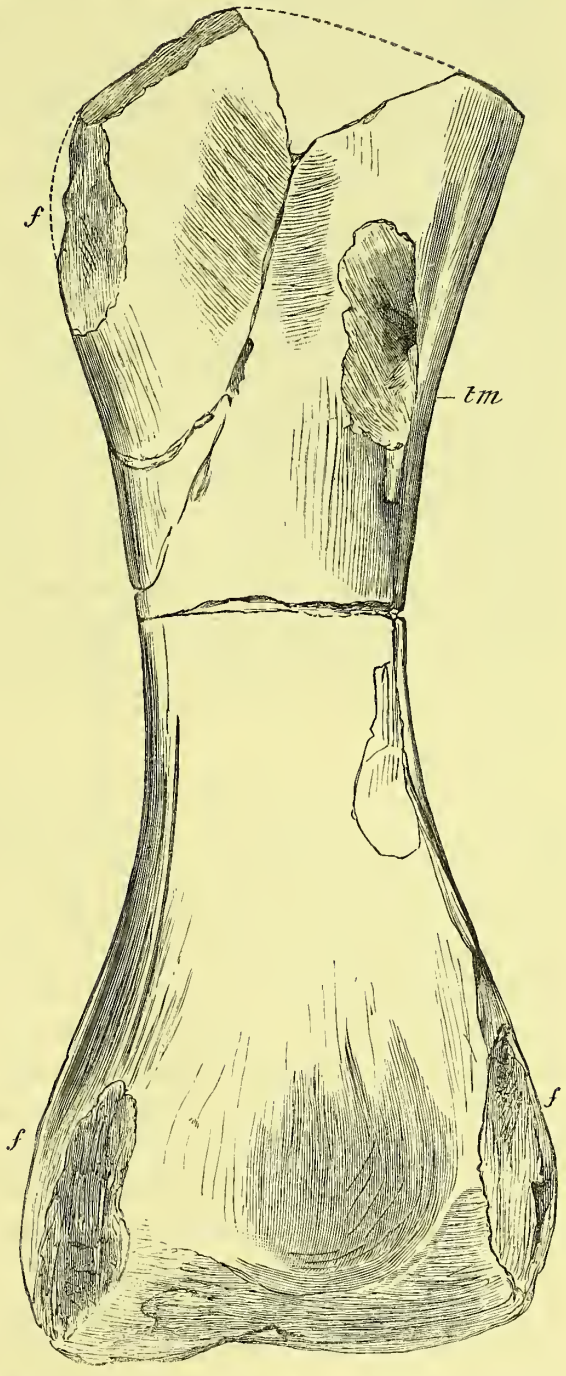
The outline of the proximal articulation is convex from within outward. It consists of a transversely ovate articular cartilaginous area, more than an inch thick (fig. 6) which is prolonged outward and downward on the summit of the outward crest, which is flattened above and concave below. There is an inflation of the bone on the superior surface, below the thickened articulation (fig. 4). Both the inner and outer proximal margins are somewhat concave, but in such a way as to give the head of the bone an inward direction. The thick inner border is convexly rounded, and there is a similar rounding to the external margin of the shaft, which is more compressed. On the under side the area beneath the external crest is concavely excavated for a distance of about $1\frac{1}{2}$ inch, and the excavation terminates in a prominent trochanter (figs. 3 and 5), which increases the thickness of the bone from $\frac{1}{2}\frac{3}{0}$ inch to $1\frac{3}{10}$ inch. The summit of this trochanter is an ovate tubercle, *t'*, which is prolonged down the shaft as a

Fig. 12.



Left femur. Nat. size.
f., fracture. *Dinosaurus* in a marine deposit with *Terebratula*.

Fig. 13.



Posterior aspect of the left femur of a species of *Rhopalodon*. *tm.*, trochanter minor; *f.*, slight fractures. Specimen figured by EICHWALD, *loc. cit.*, t. 59, fig. 5.

ridge (fig. 3), defining a concave area on its inner side and a flattened area on its outer side, so that it makes the section of the shaft triangular. This type of femur cannot belong to the same genus as the great bone figured by TRAUTSCHOLD.

It is readily distinguished by the constricted form of the shaft, the great elevation of the trochanter, and the relatively great width of the proximal articular surface. I regard it as referable to a species of *Rhopalodon* or *Dinosaurus*.

The left femur figured by EICHWALD (*loc. cit.*, plate 59, fig. 5) is particularly valuable, since it gives the length of the bone, and its characters as a whole ; for, although the proximal articular surface is lost, evidence from another specimen indicates that less than half an inch of the length of the bone is missing. As preserved, the femur is 7 inches long, and when complete did not exceed $7\frac{1}{2}$ inches. The shaft is remarkable for its transversely oblong section, $1\frac{4}{10}$ inch wide and 1 inch thick on the inner side, the external thickness being a little less. The under side is flattened, but the flattening passes distally into the concavity on the under side of the condyles, and the superior surface is gently concave in length. The shaft is margined on the angle between its inner and under sides by a ridge, intensified by crushing, which extends from the inner distal condyle (where its extremity is broken) proximally to the superior trochanter, which is compressed from side to side, and appears to be marginal like the inner trochanter in the femur of such Saurischian reptiles as *Megalosaurus* and its allies, and it is similarly placed towards the proximal end, although there is a sufficient resemblance to the under side of the femur of *Cratæomus* to suggest comparison.

The lateral trochanteroid process in the Russian fossil is broken, and the bone adjacent to it internally is slightly crushed, so as to appear flatter than it was originally, and to make the trochanter more marginal. The base of the trochanter is $1\frac{4}{10}$ inch deep, by rather less than $\frac{1}{2}$ inch wide. On its inner side is the usual concavity, on the under side of the head of the bone, defined by the compression from above downward of the external crest of the bone, which is not developed in the European Saurischian Reptilia, though some trace of it remains in the South African *Euskelosaurus*, and it eventually becomes represented by the external proximal trochanter of that group. This lateral compression of the external part of the head of the femur is characteristic of all the terrestrial genera of the Anomodont alliance, in which I have seen evidence of the bone. The transverse width of the proximal end, as preserved, measured at an angle of 45° with the distal end, is $2\frac{7}{10}$ inches ; and the transverse width of the distal end, as preserved, is about the same. The thickness of the distal end at the outer condyle is $1\frac{9}{10}$ inch, while the thickness between the condyles is $1\frac{3}{10}$ inch. The twist in the bone is not appreciable on the under side ; but on the upper side the oblique superior surface as it extends distally becomes narrower, and twists so as to become the nearly vertical external surface. The width of the distal end is almost exactly one-half the width of the distal end of the large specimen figured by VON MEYER, now regarded as *Deuterosaurus*, which is a reason for

inferring that the large femur probably did not exceed 14 inches in length. The close family likeness of this bone to the femur of *Pareiasaurus* at its proximal end is the more interesting from the differences shown at the distal end. For in the Russian fossil there is a moderately rounded trochlear extremity, indicating, I think, that the bone was carried in the body at an angle of 45°, whereas in *Pareiasaurus* the distal condyles, well separated from each other, are flattened and inclined to be concave; and there is no trace in this Russian bone of the perforation in the distal end, which passes superiorly above and between the condyles in *Pareiasaurus*. There is no proof that the inferior foramen represented by VON MEYER (plate 19, fig. 2) in *Deuterosaurus* has any relation to the inter-condylar foramen of *Pareiasaurus* and *Propappus*.

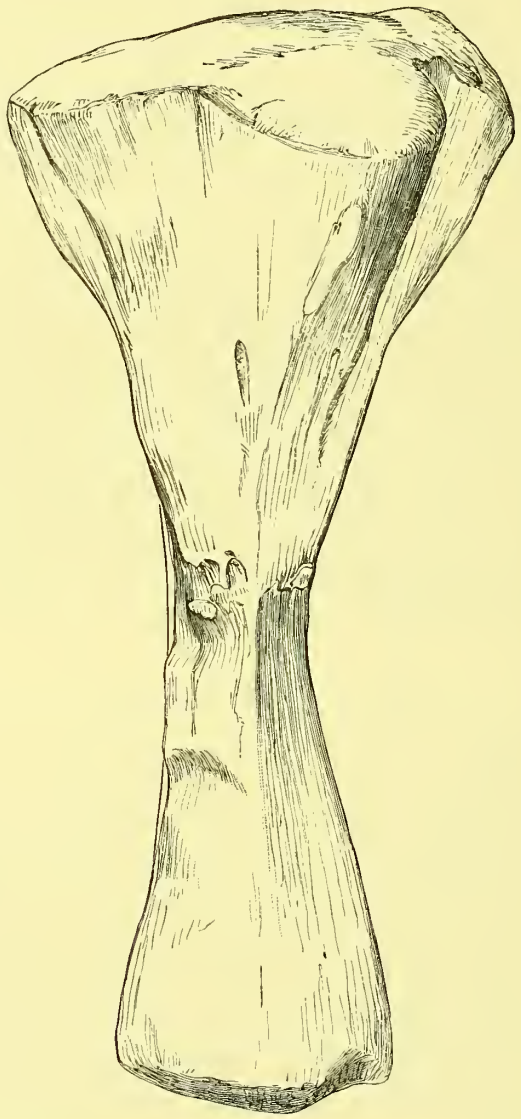
The examination of this type may have some bearing upon the interpretation of the bone described as the humerus of *Saurodesmus Robertsoni* ('Quart. Journ. Geol. Soc.,' 1891, vol. 47, p. 166), since the bone has several characters in common with the Anomodont femur as now known, but it differs from this Russian type in the greater transverse expansion of the proximal and distal ends, in the increased compression of the internal distal margin, and in the inward direction and greater development of the proximal trochanter. If the late Mr. CHARLES MOORE'S investigations are taken as determining the age of the boulder at Linksfield from which it was obtained, as being of Rhætic Age, the fossil may indicate the first occurrence of an Anomodont reptile in the Rhætic beds of Britain.

Tibia of Rhopalodon.

In the 'Palæontographica,' vol. 15, plate 21, figs. 9–11, VON MEYER figured a fragment of bone which is stated to have some resemblance to the upper part of the femur of *Nothosaurus*, and to show no trace of a medullary cavity. This specimen is, I believe, better understood by comparison with the tibia of *Pareiasaurus*, which has been figured ('Phil. Trans.,' 1889, B, Plate 22, fig. 4, and Plate 23). From that comparison it seems a reasonable inference that the Russian bone is the proximal end of a tibia. There is a similar contraction of the shaft of the bone from the articular surface downward, the same kind of longitudinal groove at the proximal end of the bone as is seen in *Cryptobranchus*, and some similarity in the truncation of the proximal end by two inclined condylar surfaces, which are respectively internal and external. The Russian bone has the ridge on its fibular side much less developed than is the median anterior ridge, which gives to this fossil a sub-triangular contour at the proximal end, which is unlike the somewhat comma-shaped proximal outline of the bone in *Pareiasaurus*. As drawn by VON MEYER, the fragment is 3 inches long, $2\frac{6}{10}$ inches wide at the proximal end. It indicates a bone about 6 inches long. VON MEYER has also figured (plate 20, figs. 3, 4, 5) a fragment which he compared to the distal end of the femur of *Nothosaurus*. By comparison of the outlines of the distal

fracture of the former fragment with the proximal fracture of this, it seems to me almost certain that these are portions of one bone, and therefore, that the second fragment is the distal end of the tibia; only VON MEYER has represented the posterior instead of the anterior aspect.

Fig. 14.



Tibia restored from VON MEYER'S specimens.

If the distal end is compared with that of the tibia of *Pareiasaurus* ('Phil. Trans.,' 1889, B, Plate 23, fig. 3), it will be seen to have a similar reniform outline, flattened behind, and convex in front; though the Russian bone is relatively stouter, and its distal articular surface is not concave. The width of the distal end, as drawn by VON MEYER, is $1\frac{7}{10}$ inch. The distal articular surface appears from the figure to have had an oblique relation to the tarsus, which is not identical with *Pareiasaurus*.

Putting the two fragments together they give the form of the bone, which is here outlined, of the natural size.

[Since this was written, Dr. F. KINKELIN has had the kindness to compare these fragments with each other. Finding them to unite, he has obligingly had a cast of the entire tibia made, and sent to me with casts of most of the other specimens figured by VON MEYER. These casts will be deposited in the British Museum.]

Fibula of Rhopalodon.

EICHWALD figured in the 'Lethæa Rossica,' plate 57, fig. 29, a fragment of bone, $3\frac{1}{2}$ inches long, which I regard as probably the distal end of the fibula. That identification rests upon the curved form of the fibula, which was found resting upon the sacral region of the skeleton of *Pareiasaurus Baini*, and the similar evidence of curved form of the bone in the skeleton of a Dicynodon, with the bones preserved in natural association, from the Baavian's river, preserved in the Albany Museum.

The fibula in *Pareiasaurus* is large at the distal end. At the proximal end it is imperfect. It is necessarily shorter than the tibia in *Pareiasaurus*, owing to its different mode of union with the tarsus. EICHWALD'S fragment at the distal end is $1\frac{1}{2}$ inch wide, with a somewhat oblique and compressed articular surface, such as might have given attachment to the tarsus, and the fracture in the middle of the shaft gives a width of $\frac{4}{10}$ inch. The shorter tibial border is concave and $2\frac{7}{10}$ inch long, as represented in the figure, while the moderately convex external border rather exceeds $3\frac{1}{2}$ inches.

Among the fragments figured by VON MEYER, 'Palæontographica,' plate 20, figs. 8, 9, 10, 11, is a small proximal end of a bone, broadly cordate in its proximal outline, with only $1\frac{1}{2}$ inch of the shaft preserved. Its sides converge distally, on the hypothesis that it is a proximal end, and it terminates in a transverse ovate section $\frac{13}{20}$ inch wide and $\frac{4}{10}$ inch thick. There is a small proximal process developed. It is impossible to determine this bone with certainty without comparison; but its resemblance in thickness to the bone just mentioned, led me to regard it as a possible proximal end of the fibula.

The Foot Bones of Rhopalodon.

The only evidence of the extremities of the limbs is a single bone which EICHWALD figures, plate 58, fig. 12. It was regarded by him as a phalange, and compared to the phalanges of *Mastodonsaurus*. It has the general aspect of a phalange of a Plesiosaur. The drawing indicates a bone $1\frac{1}{20}$ inch long, compressed from above downward, concave at the sides, expanded at the ends, with a transversely truncate surface at the proximal end, and a convex surface at the distal end. These ends are $\frac{13}{20}$ inch wide, and the bone is $\frac{4}{20}$ inch wide in the middle. In proportion, it is similar

to the metacarpal and metatarsal bones of *Pareiasaurus*, but is stouter than the digital bones of *Eurycarpus*,* and relatively shorter. Its form suggests that it may be metatarsal or metacarpal, its size is more like what might be expected in a phalange of an inner digit. The transverse measurement across five such bones would be $3\frac{1}{2}$ inches if they were in close contact, and this is the only indication available of the possible dimensions of the foot in Rhopalodon.

Conclusion.

From this examination of evidence old and new it seems to me established that—

(1). The Russian Permian Reptiles discussed are closely allied to the South African types, but cannot be placed in the same subordinal groups.

(2). The skull appears to resemble Placodonts and Nothosaurs in the structure of the palate, and has no feature in common with the Theriodontia; although the dentition is closely comparable to that of South African Theriodonts in plan. In its occipital aspect it resembles Plesiosaurs, Nothosaurs, and Placodonts so closely as to suggest that it may be a terrestrial representative of the Placodont group. The modification of the cerebral cavity in relation to the pineal eye is better paralleled in Theriodontia than in any other group of animals.

(3). The vertebral column is indicative of animals in which the tail was absent or short and the presacral region was long. There are evidences in specimens at present unfigured that this condition may have characterized some Theriodonts from South Africa; and the presacral elongation of the vertebral column may be compared with the condition in Nothosauria. But while Nothosaurs have the vertebral articulations for the ribs vertically deep and less divided from each other than among Pareiasaurians, the Russian types have the double headed articulation of the ribs which I believe to characterize most if not all Theriodonts, on the evidence of undescribed African specimens already referred to, though the mode of articulation of the head of the rib in these Russian specimens is distinctive. The sacrum is suggestive of some Nothosaurian bones, and of the Pareiasaurian sacrum in the developement of the first sacral rib, but it differs apparently from Theriodonts in including only two vertebræ.

(4). The shoulder girdle closely approximates to the Pareiasaurian and to the Dicynodont type in the flatness of the scapula and in composition.

(5). The pelvis is less developed than in any of the South African types; the ilium is more Theriodont than Dicynodont, the pubis appears to be no more developed than in Ichthyosaurus or Dicynodonts, but is typically blended with the ischium as in Saurischia, Ornithosaurs, and Anomodonts.

(6). The humerus and fore-limb, as far as known, are similar to those of Dicynodonts.

* I obtained in South Africa, further evidence of the skeleton of *Eurycarpus*, which shows some of the limb bones, like the humerus, to diverge less from the Dicynodont type than at first was inferred from the single specimen.

(7). The femur has much in common with *Pareiasaurus*, and the tibia has a similar modification of its proximal end, which suggests the configuration in *Cryptobranchus*.

On the whole the resemblances seem to indicate a strong affinity between this group which may be termed Deuterosauria, and the Placodontia and Theriodontia. This implies near affinity between the Theriodontia and the Nothosauria, but apparently indicates that the Theriodont dentition has originated from more than one source. The resemblances in parts of the skeleton between the Deuterosauria and Sauropterygia though much less important, are suggestive of a more distant affinity between those groups of animals.

The probable forms of the skeleton in the two genera described, may be gathered from the diagram outlines which exhibit the bones at present known, all drawn of the natural size and reduced, except the pelvis of *Deuterosaurus*, which is enlarged.

The Deuterosauria are defined as Anomodontia, distinguished from the other known groups by having (1) the palato-nares divided by the vomer, without any hard palate extending over them. (2.) The canine teeth are serrated (and large) with incisor teeth in front (in *Deuterosaurus*) and molar teeth behind. There are temporal vacuities, and a pineal foramen. (3.) There is a facet for the head of the rib on the (middle dorsal) vertebra, and no proof that it was attached to the surface between two centrums in any vertebræ; the tubercle is attached to a transverse process. The lower dorsal ribs have no antero-posterior expansion. (4.) There are two sacral vertebræ, anchylosed. (5.) The ilium has a small crest without conspicuous anterior development. The acetabulum is imperforate, as in Dicynodontia and Ornithosauria. The limb bones and shoulder girdle are strong. (6.) The scapula is flat.

The two genera appear to be the types of two distinct families, Deuterosauridæ and Rhopalodontidæ, distinguished by structure of the temporal region of the skull, which has a median parietal crest in the former, and is roofed over on the superior surface in the latter. In the former, the incisor teeth are strongly developed; in the latter, serrated lanceolate molars are strongly developed behind the canines.

Deuterosaurus

Has the skull compressed from side to side, with large transversely compressed incisor teeth. The lachrymal bone is greatly developed. The post-orbital arch is deep, and situate below the orbit. The quadrate bone is large, and developed below the foramen magnum on the type of *Placodus*. The vertebræ are biconcave. The ribs are long. The sacral ribs are well developed. The scapula is expanded at its free end. The pubis and ischium diverge from below the acetabulum; there is a supra-acetabular articular wedge on the ilium.

Rhopalodon

Has the skull more elongated and less deep, with the superior temporal vacuities roofed with bone. The orbit is relatively far back, defended with a circle of sclerotic bones. The incisors are not clearly evidenced. The canines are large. The lanceolate molar teeth are of Megalosaurian type. The vertebræ are biconcave. The scapula is concave on its borders, without conspicuous expansion at the free end. The pubis and ischium do not manifestly diverge ventrally; there may be a supra-acetabular articulation on the ilium.

I am glad to express my thanks for the way in which my work was facilitated by the good offices of the Officials of the Foreign Office in London, and of the Officials of the British Embassy in St. Petersburg; to the Governing body of the Institute of Mines of St. Petersburg, to M. F. Schmidt, to Dr. A. Karpinsky, and to Professors Lehusen and Inostranseff for the exceptional facilities afforded me for the study of these remains; to Professor Stukenberg of Kazan, and to Professor A. Pavlow of Moscow. I am indebted to Professors Dames and Kocken for the opportunity of studying specimens in Berlin, and to Dr. Kinkelin for the loan of specimens from the Senckenberg Museum, Frankfort-on-Main, and for casts of von Meyer's types; and to the Government Grant Committee of the Royal Society for assistance in carrying on the investigation.

Description of Plates.

PLATE 60.

Fig. 1. Left side of the skull of *Deuterosaurus*: *pf.*, parietal foramen; *p.*, parietal bone; *pt.*, post-frontal; *prf.*, pre-frontal; *mx.*, maxillary; *l.*, lachrymal; *pm.*, pre-maxillary; *cn.*, canine; *mr.*, molar; *pn.*, palatine; *q.*, quadrate; *sq.*, squamosal; *tr.*, temporal vacuity occupied with matrix; *o.*, orbit of the eye occupied with matrix in which are shells of *Modiolopsis Pallasi*. Half natural size.

Fig. 2. Fragment of the canine tooth (*cn.*) showing vertically fractured crown (*c.*) and root (*r.*), natural size, reversed. *m.* is the molar tooth, natural size.

Fig. 3. Impression of a portion of the palate of the skull of *Deuterosaurus*, seen from beneath, drawn of the natural size. *pt.n.*, palato-nares; *pm.*, pre-maxillary; *cn.*, canine tooth; *mx.*, maxillary; *pn.*, palatine bone; *f.*, fracture of portion of palatine bone; *mr.*, malar; *t.*, transverse bone; *pty.*, pterygoid; *v.*, vomer. The lateral ridges formed by the palatine and transverse bones, which converge as they extend behind the palato-nares,

form a depression in the middle of the palate in which the long, narrow narial vacuities are placed.

PLATE 61.

Fig. 1. Skull of *Deuterosaurus* seen from above; one-half natural size. *pf.*, parietal foramen; *p.*, parietal bone; *sq.*, squamosal bone; *pt.f.*, post-frontal; *pr.f.*, pre-frontal; *f.*, frontal bone; *mx.*, maxillary; *pm.*, pre-maxillary.

Fig. 2. Posterior aspect of the skull of *Deuterosaurus*, from which the cranial bones have been broken away, leaving the impressions, chiefly on the left side. One-half natural size. *pf.*, parietal foramen, with the vertical canal below it which leads into the brain, in front of the foramen magnum (*f.m.*); *sq.*, squamosal bone; *q.*, quadrate bone; *b.sp.*, basi-sphenoid; *pt.*, pterygoid bones; one half natural size.

Figs. 3 to 6. Proximal end of left femur of a species of *Rhopalodon* or *Dinosaurus*; natural size. Fig. 3, inferior; fig. 4, superior; fig. 5, external; fig. 6, proximal; *p.*, proximal articular surface; *t'.*, inferior trochanter minor prolonged distally in a ridge; *t''.*, external trochanter major, which is not reflected upward.

PLATE 62.

Fig. 1. Sacrum and pelvic bones seen from above, probably *Deuterosaurus*. *Il.*, ilium; *s.r.*, sacral rib; *n.s.*, neural spine; *pz.*, pre-zygapophysis; natural size.

Fig. 2. Anterior aspect of the same specimen showing the squamous union between the sacral ribs and the iliac bones.

Fig. 3. Ventral aspect of the sacrum showing the union of centrum and sacral rib.

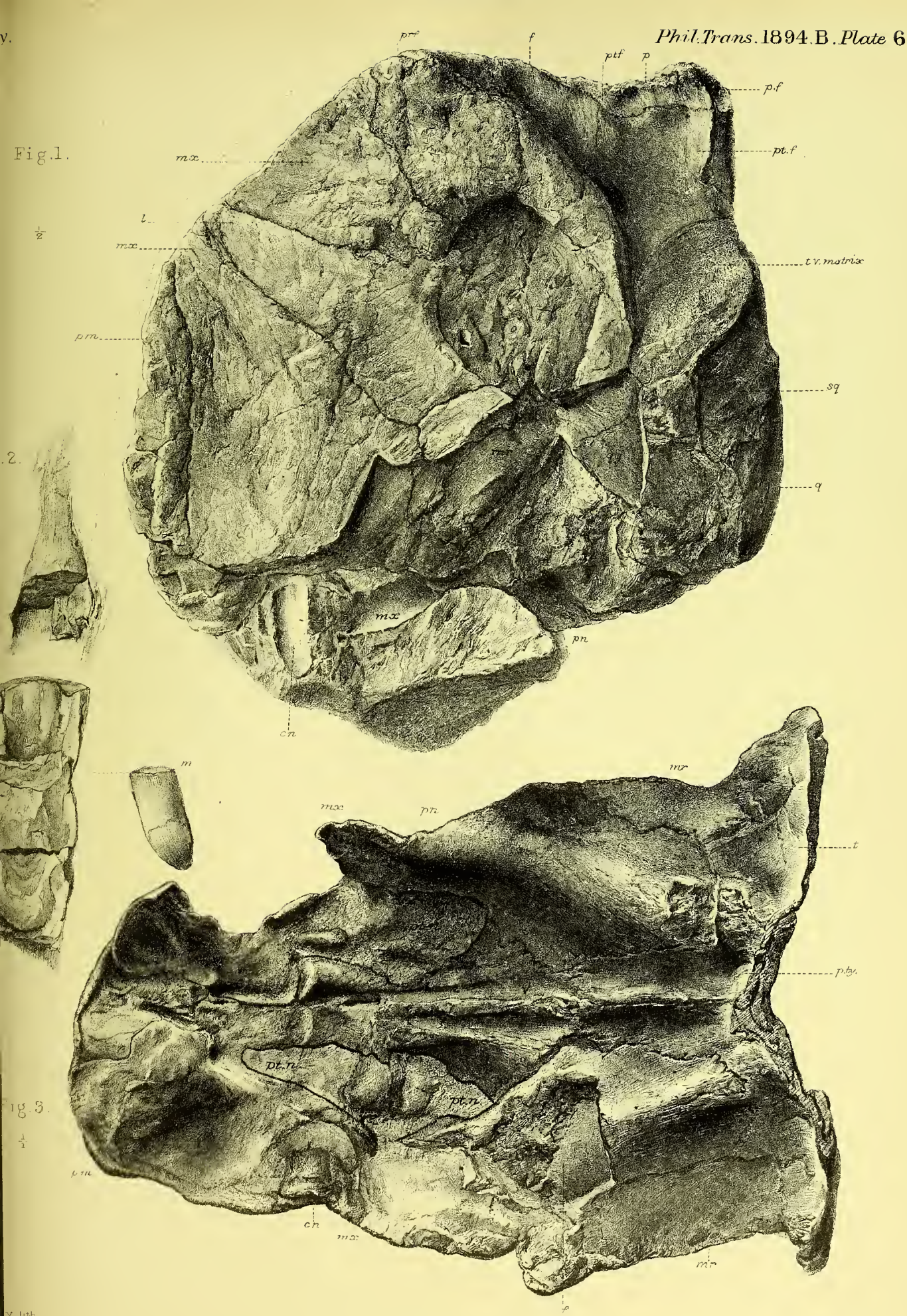
Fig. 4. Left ilium. *a.w.*, supra-acetabular wedge; *is.*, ischium.

PLATE 63.

Fig. 1. Right side of the skull of *Rhopalodon*; natural size.

Fig. 2. Right maxillary molar tooth showing serrated margin; twice natural size.

Fig. 3. The same skull seen from above. *P.f.*, parietal foramen; *p.*, parietal; *pt.f.*, post-frontal; *pr.f.*, pre-frontal; *o.*, orbit; *mx.*, maxillary; *c.*, canine; *mn.*, mandible.



Skull of Deuterosaurus.

Fig. 1.
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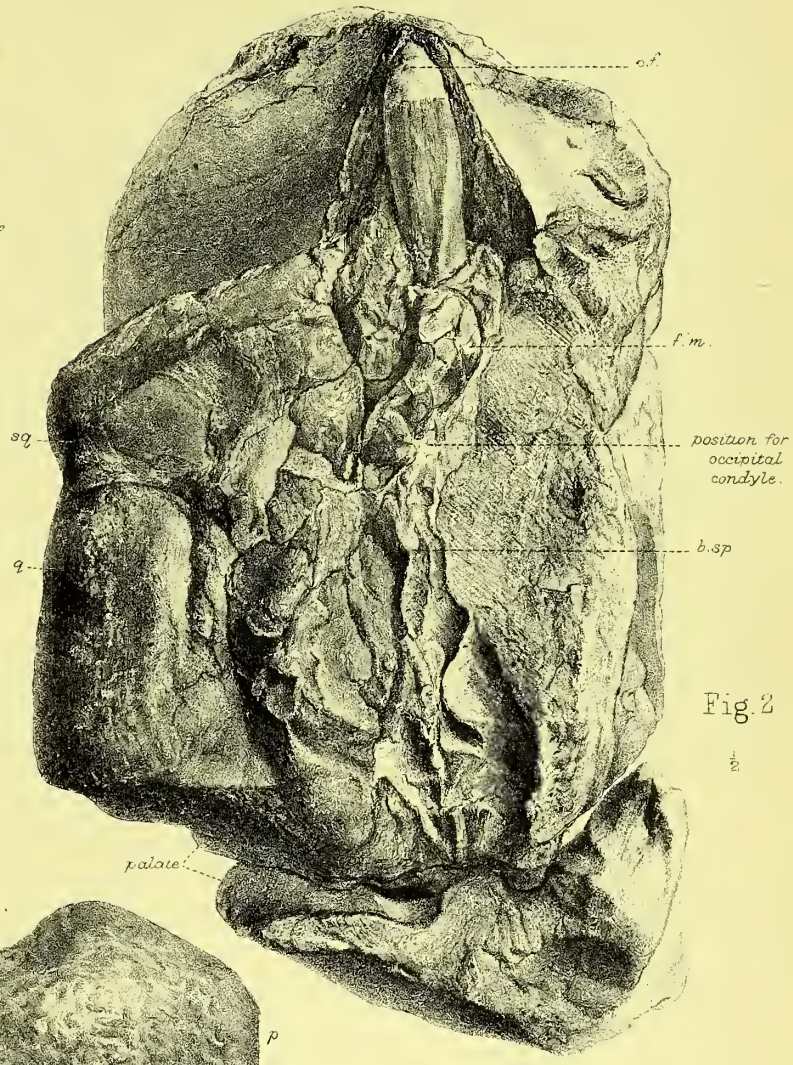

Fig. 2
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Fig. 6.

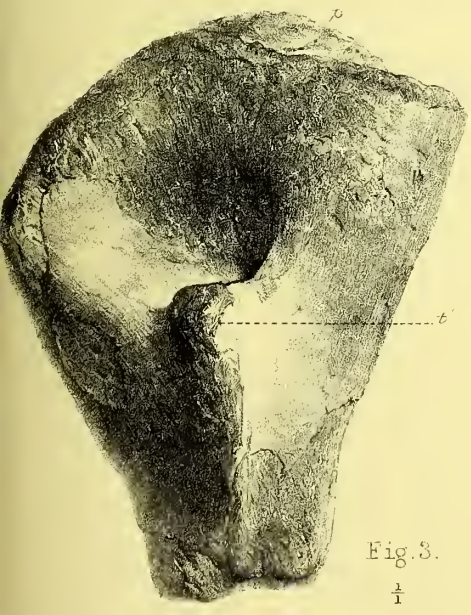

Fig. 3.
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Fig. 4.

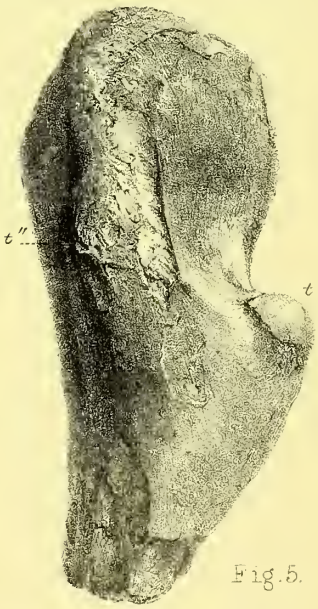
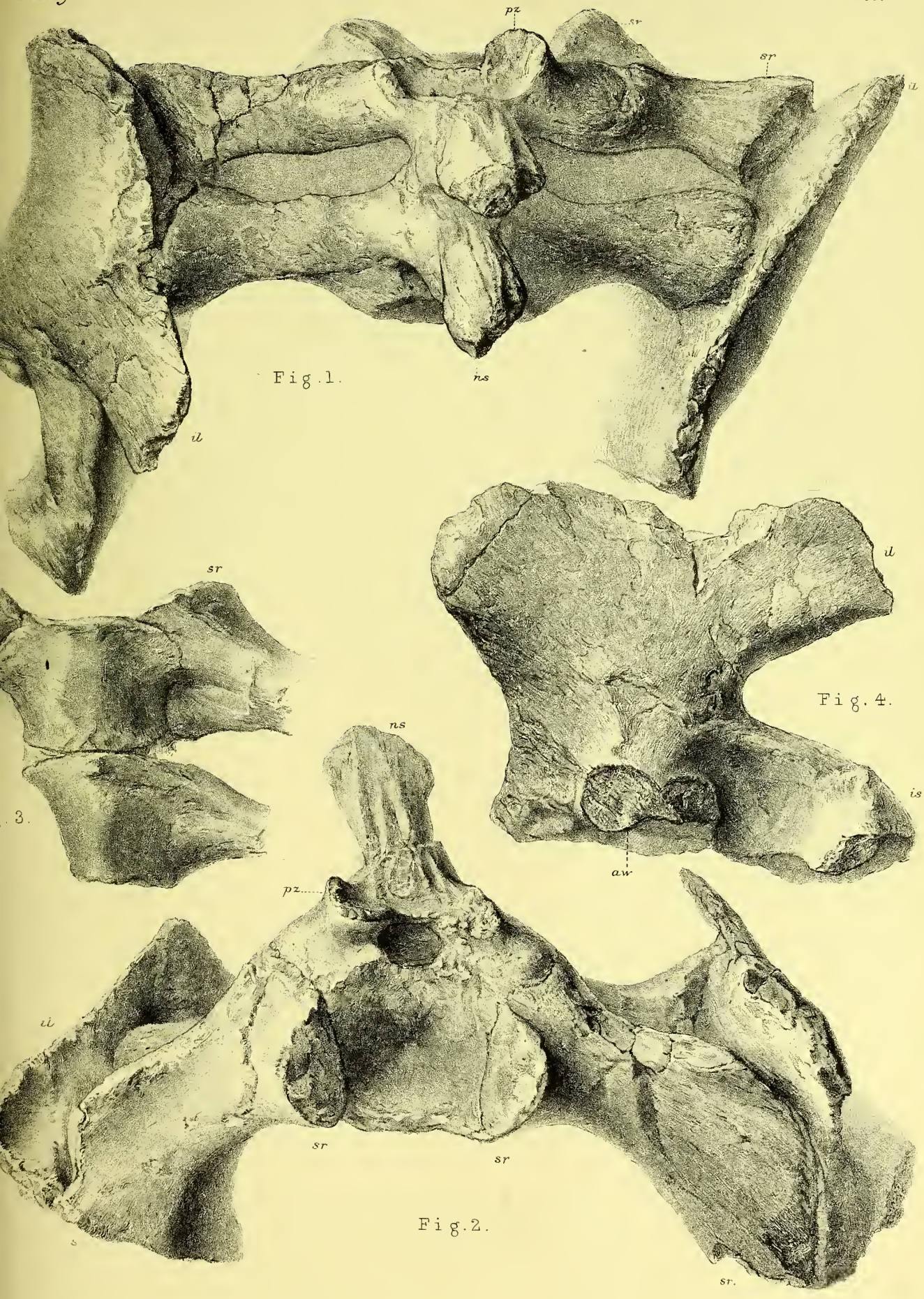


Fig. 5.

W.H. Wesley lith.

West, Newman imp.

Skull of Deuterosaurus; and femur.



Sacrum and pelvic bones, $\frac{1}{4}$.

J.Wesley lith. West,Newman imp.

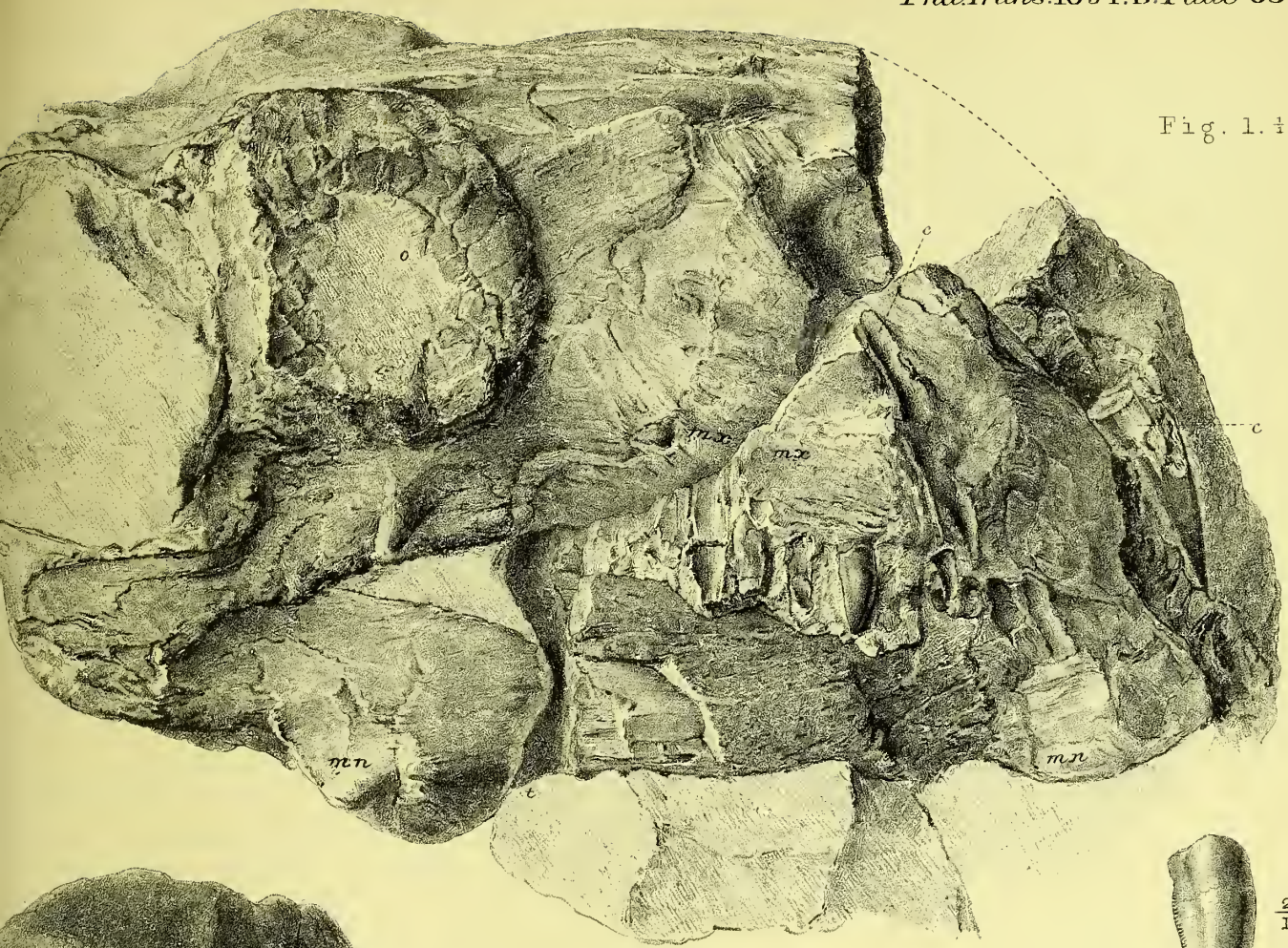


Fig. 1. $\frac{1}{4}$

Fig. 2. $\frac{2}{1}$

Fig. 3.

Skull of Rhopalodon.